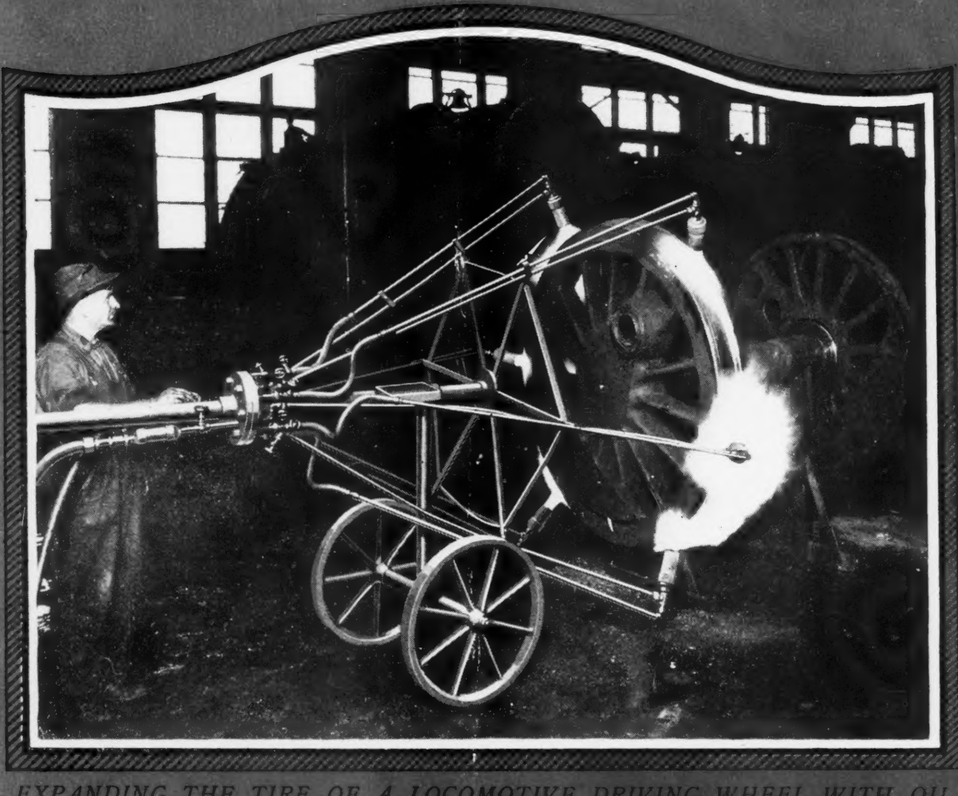
Compressed Air Magazine

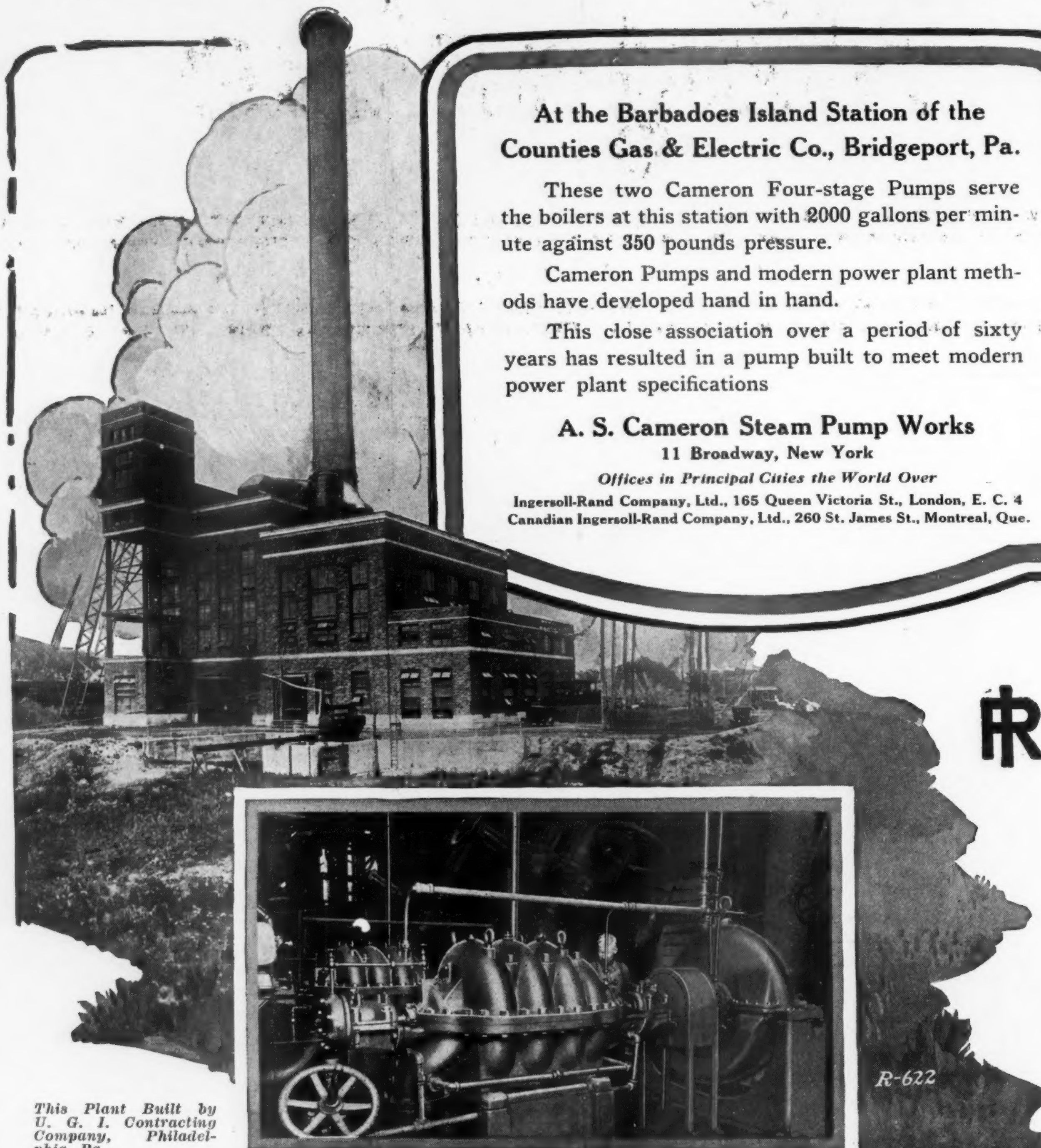
Vol. XXX, No. II London New York Paris 35 Cents a Copy

FEBRUARY, 1925
CIRCULATION THIS ISSUE
24,260 COPIES



EXPANDING THE TIRE OF A LOCOMOTIVE DRIVING WHEEL WITH OIL TORCHES OPERATED BY COMPRESSED AIR

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)


R-622

Compressed Air Magazine
NEW YORK · LONDON · PARIS
Principal Offices:
BOWLING GREEN BUILDING
No. 11, BROADWAY,
NEW YORK.

VOL. XXX, NO. II

FEBRUARY, 1925

Driving a Tunnel Through the Continental Divide

What the Moffat Tunnel Will Mean to Colorado and to the Country at Large

By ROBERT G. SKERRETT

PART I

DAVID H. MOFFAT dreamed of the day when Denver and certain sections of Colorado to the north and west should be able to make the most of their natural advantages. He did more than dream, for he gave of his best and of the fulness of his material resources to make his dream come partway true.

From Denver up over the crest of the Continental Divide he built a railroad despite appalling physical obstacles—carrying his line to an altitude of 11,660 feet where the road has since battled continually with Nature in her grimmest moods. Thence the railway was run into territory otherwise nearly inaccessible, where deposits of minerals, incalculable in extent and value, were formed when the Rocky Mountains were in the making.

But Moffat's railroad was only an expedient: his abiding desire was to drive a tunnel right through the backbone of the obstructing range so as to put Denver on a direct transcontinental route.

David Moffat did not live to see his splendid project started; but his initiative and his courageous example have borne fruit at last, and the tunnel of which he dreamed is now in course of construction.

DENVER came into being in 1859 as an immediate result of the discovery a year earlier of gold in the contiguous region. Since its incorporation, Denver has developed from little more than a mining camp into a fine and enterprising municipality of approximately 325,000 inhabitants. Even so, this growth of Colorado's capital has undoubtedly been hampered by the proximity of the very mountains whose mineral riches have played so large and so essential a part in the city's evolution.

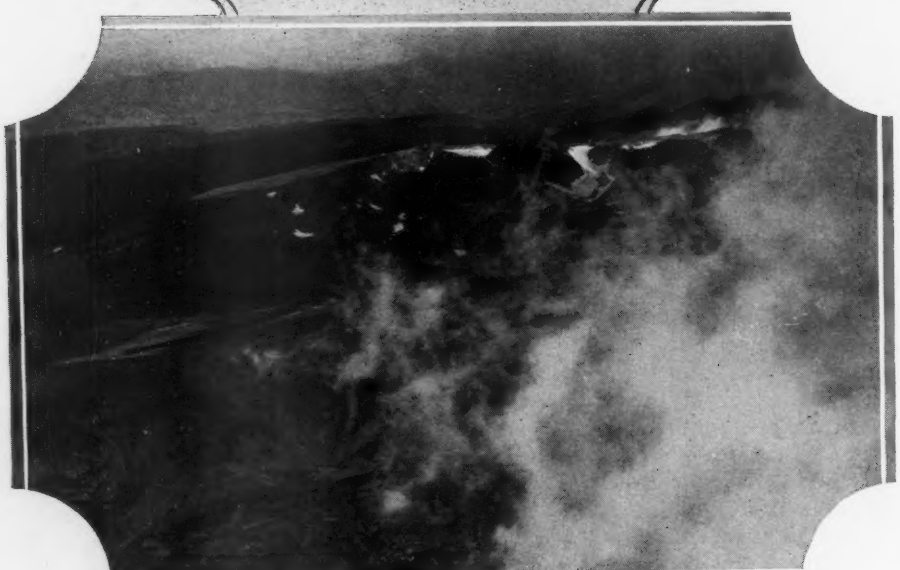
Ages and ages before the lure of gold attracted the restless prospector to the eastern foothills of the Rocky Mountains, that range was formed by a succession of seismic convulsions which pushed the earth's crust skyward many thousands of feet. This towering barrier, now known as the Continental Divide, runs north and south through the middle of Colorado and has served effectually to hold Denver aside from the direct path of any of the transcontinental rail routes which trace their ways from the Atlantic to the Pacific.

Denver has suffered commercially and industrially because of this relative isolation; and the obstructing mountains have also interfered with the exploitation of other sections of the State of Colorado that are veritable treasure houses of natural riches. No wonder, then, that this physical situation should have inspired men of large vision, interested in making the most of Colorado's resources, to seek ways and to devise means by which the towering bulwark of the Continental Divide could be surmounted or neutralized so that Denver might be linked by less circuitous rail routes with the great tide of traffic flowing from shore to shore of our flanking seaboards.

As matters stand today, and have stood for decades, Denver is entered from the east by no fewer than six trunk lines which follow easy paths of approach over the great plateau that forms the eastern two-fifths of the state and gradually attains an altitude at Denver of nearly a mile above sea level. But to reach the Pacific coast only two railroads offer an outlet. One of these runs northward for 106 miles and the other travels nearly due south for 119 miles before there are breaks in the mountain wall through which they can penetrate westward. An accompanying map plainly reveals Denver's predicament and shows how the railroads are obliged to go hundreds of miles out of their way not only to touch that city but to traverse the Rockies at all. Further, a little study of a map of Colorado will make it clear that a very considerable area of the state is without railway transportation.

Within Colorado there are 43 mountain peaks which rise to heights of 14,000 feet and more, and the main range of the Rockies constituting the Continental Divide is supplemented by numerous secondary ranges and spurs that run in all directions. While these mountains afford varied and unsurpassed scenic wonders still they have interposed very serious obstacles to railroad builders and have, unquestionably, arrested agricultural expansion and the development of the state's unsurpassed mineral resources.

As far back as 1861, an army engineer, Capt. E. L. Berthoud, surveyed a route across the pass which now bears his name. This was the first serious effort to discover a way by which a railroad might cross the Continental Divide. The crest of this pass is at an elevation of 11,306 feet and is 62 miles west of Denver. It is over the road blazed by Captain Berthoud that thousands of motorists travel to and fro during the open months of the year. From time to time since 1861, others have sought routes over the Divide that could be utilized by railroads, but the only one that has served this purpose is Rollins Pass lying ten miles north of Berthoud Pass and at an elevation of 11,660 feet above



Top—Arapahoe peak and glacial lakes near the line of the Moffat Tunnel.

Middle—Crest of the Continental Divide as seen from an airplane flying above the tunnel line.

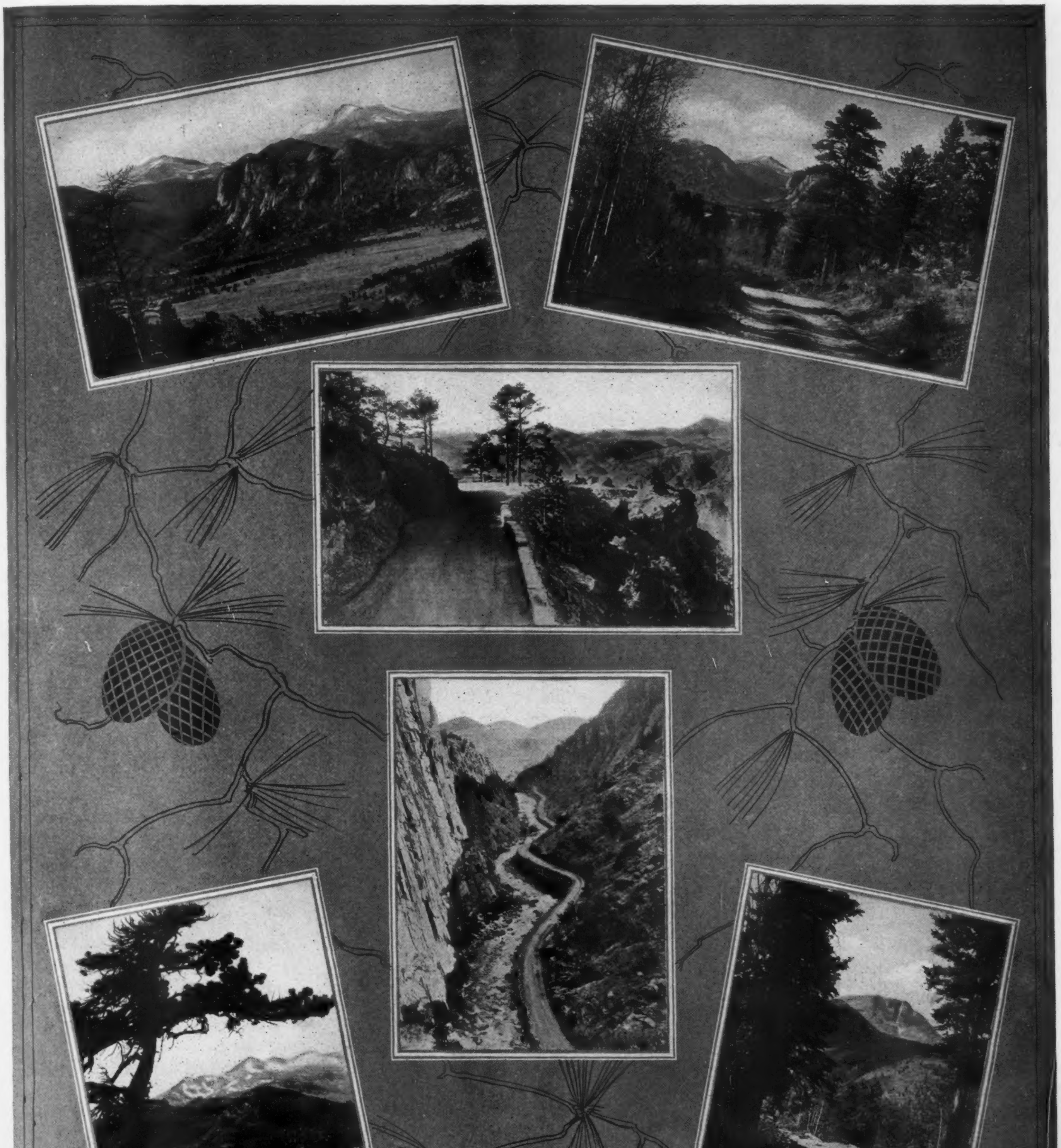
Bottom—Far above Rollins Pass showing snowsheds, at left, built over the tracks of the Moffat Railroad where it now crosses the Continental Divide.

sea level. Long before the days of the white man in that region the Ute and the Arapahoe Indians used Rollins Pass—the Utes going eastward onto the plains to kill buffaloes to get robes for winter while the Arapahoes went from the plains westward into the mountains to shoot deer for needful buckskin and to cut tepee poles from the stands of lodgepole pine found at elevations ranging from 8,000 to 10,000 feet.

Many a fierce battle was fought in the neighborhood of Rollins Pass; and there are still evidences of the unique stone defenses erected by the Utes to hold back the invading red men of the plains. John Quincy Adams Rollins, after whom the pass was named, is said to have led a party of Mormons westward over the trail in 1865. So much for some of the historical background of Rollins Pass which is of especial interest to us now because it is through this storm-swept notch in the Continental Divide that the Denver & Salt Lake Railroad threads its toilsome way in order to link Denver with Craig, the county seat of Moffat County, in the northwest corner of the state. Because of the part played by David H. Moffat in building this road from Denver to Steamboat Springs, the line is familiarly known as the Moffat Railroad.

Much as we should like to describe at some length the physical as well as the monetary obstacles which "Dave" Moffat had to surmount to get his road started and to carry it up over Rollins Pass and onward to Steamboat Springs, the space at our disposal does not permit of this. Almost from start to finish he had to contend with the powerful and the persistent opposition of capitalists allied with certain transcontinental railroads. What he accomplished seemed on many occasions little short of impossible; and into this ambitious venture went substantially the whole of his personal fortune made in helping to make Denver and Colorado at large what they are today.

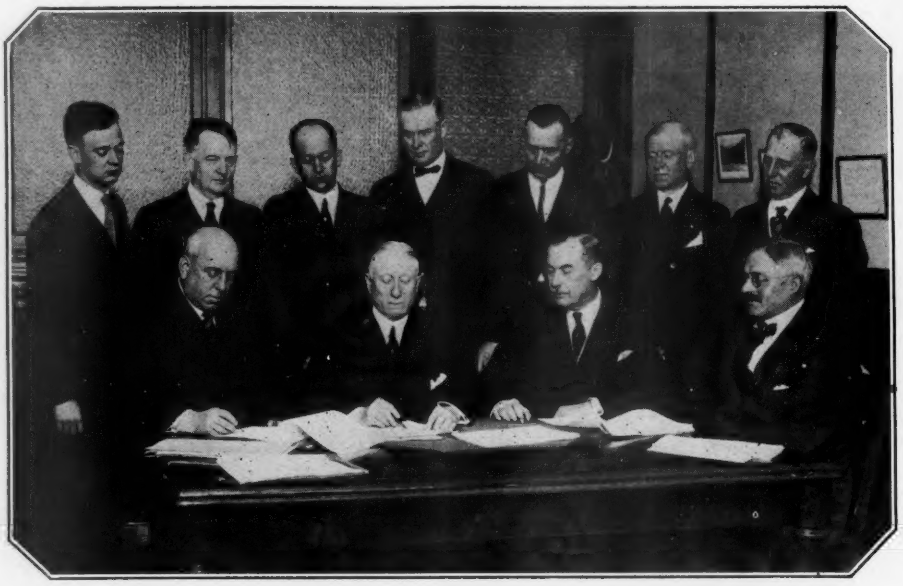
Moffat's purpose was to join Denver and Salt Lake City by rail route which would be considerably shorter than that of either of the competing lines of transportation and thus provide an important link in a more direct and a more economical run from coast to coast. As the Denver, Northwestern & Pacific Railroad, the line was incorporated in 1902 with Moffat as president and William G. Evans as vice-president. Construction was started very shortly thereafter, and the work went steadily onward with no serious interruption until 19[illegible] when Yarmony was reached at a distance of 130 miles from Denver. When the outlook seemed blackest during that year, Denver capital came to the rescue, and the money they raised sufficed to extend the road to Steamboat Springs, 84 miles beyond. It might be mentioned here that just after leaving Kremmling and before arriving at Yarmony, a few miles away, the railroad passes through Go[illegible] Canyon, and construction at that point was held up for several years by the United States Department of the Interior on the score that the neighboring area could be used to advantage as a reservoir. President Roo[illegible]



Not without reason is Colorado described as a scenic wonderland. Within its borders there are no fewer than 43 majestic mountain peaks which raise their heads skyward to heights of 14,000 feet and more. As might be expected, the valleys of this rugged country are marvelously alluring and picturesque. The foregoing illustrations give a hint of the diversified character of the region adjacent to the Moffat Tunnel and of the sections of the state tapped or traversed by the railways which will use the tunnel.

velt finally came to the rescue and decided that the railroad would be of more benefit to the people than a reservoir.

The original purpose of Moffat and his associates was to penetrate the Continental Divide west of Denver by means of a tunnel running from the source of South Boulder Creek, on the east, to the headwaters of the Fraser River on the west slope. But it was recognized that the driving of a tunnel would take a number of years; and, in order to hold the right of way through Gore Canyon and other strategic points, it was necessary that the road be advanced with all practicable dispatch. Therefore, the line was carried up over Rollins Pass; and to do this a series of loops and hairpin curves were resorted to—a gradient of 4 per cent. being required for a good many miles to make it possible for trains to reach the summit of the climb. But this engineering victory, for such in truth it was, only partly solved the problem—there still remained the staggering operative task of bucking deep snow drifts formed by the whirling eddies of driving gales which sweep over the Divide during the winter months. It is no unusual thing for traffic to be thus blocked for days and even weeks despite long stretches of snow sheds and the services of powerful rotary plows. It has been authoritatively estimated that notwithstanding these facilities fully 41 per cent. of the cost of running the road is attributable to fighting snow blockades, and the bulk of this work is in the vicinity of Corona which is an engine-changing station at the summit.



Courtesy, The Denver Post.

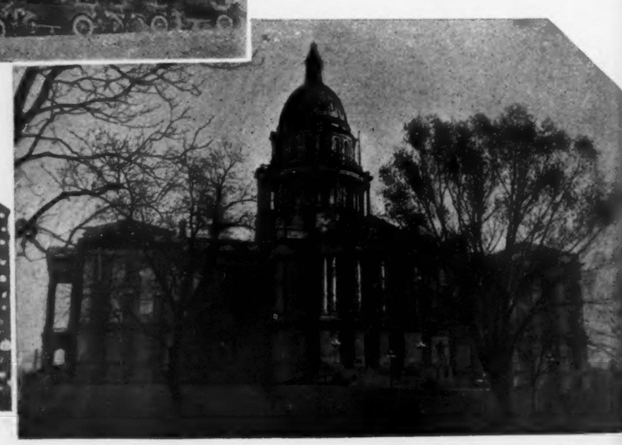
A momentous occasion: signing the contract for the Moffat Tunnel on September 19, 1923.

From left to right—Seated, F. C. Hitchcock, president of Hitchcock-Tinkler, Inc.; W. P. Robinson, president of the commission; C. C. Tinkler, vice-president of Hitchcock-Tinkler, Inc.; and R. H. Keays, chief engineer of the commission.

Standing, members of the Moffat Tunnel Commission, Erskine R. Myer, attorney; Norton Montgomery, chief counsel; Charles J. Wheeler, vice-president; George Lewis, assistant to the president; Charles H. Leckenby, secretary; Charles MacAllister Willcox, vice-president; and W. N. W. Blayney, treasurer.

Most of the tonnage hauled eastward on the Moffat Railroad has been coal mined in the state, together with considerable shipments of lumber and of livestock. The line has offered the only rail outlet for those state-produced resources, and, conversely, the development of these industries has been limited by the capacity of the road to handle their commodities. What improved transportation would mean can be gathered from the established geological fact that there is enough high-grade coal in northwestern Colorado—the territory tapped by the Moffat Railroad—to supply the entire United States for 1,500 years. From the oil-shale beds lying within the same area it will be practicable, so we are told, to produce ten times the volume of oil which we have already withdrawn from all the petroleum wells in this country. Not only that, but petroleum has been found in the Hamilton dome, 16 miles southwest of Craig, at a depth of 3,804 feet—a single gusher bringing in 4,570 barrels a day. Manifestly, the exploitation of these natural riches will keep pace with any improvement in the railroad by which they can be moved profitably to outlying markets.

The country tributary to the Moffat road is known to contain gold, silver, copper, lead, tungsten, zinc, iron, graphite, carnotite, etc., and besides the foregoing metals there are large deposits of asphalt, fluorspar, gypsum, granite, marble, limestone, sandstone, and other non-metallic minerals. Up to the present time agriculture has lagged, although there are sections which would lend themselves to a wider raising of livestock, to general farming, and to the cultivation of many kinds of fruit. As a playground for the tourist, as a region of scenic wonders, and as a haven for the health seeker, the Continental Divide and the mountainous area to the west of it offer an endless variety of attractions. Steamboat Springs boasts



Top—Union Station for the several railroads entering Denver. Left—Denver is justly proud of her fine public market. Right—The state capitol building occupies a commanding position.

What happens when a train is held up by the driving snows that are of frequent occurrence in the neighborhood of Rollins Pass.

fewer than 157 different sorts of mineral waters; and it is claimed for Hot Sulphur Springs that it is the third strongest radio-active spa in the world. In short, the Colorado Rockies can duplicate the medicinal virtues of any of the famous European resorts and, in some instances, even surpass the best of those well-known springs. And now let us briefly sketch some of the reasons why the Moffat Railroad has not been equal to the opportunities offered it by the country through which it runs.

Even when not hampered by drifting snow, and under the most favorable conditions, a freight train of 22 cars—representing a total weight of 1,200 tons—requires 4 powerful Mallet type locomotives to draw it up the 4 per cent. gradient and "over the hill." To pull a 24-car train would require the service of an additional locomotive. This indicates how near to the limit of their tractive capacity 4 locomotives work when climbing with a train of 22 loaded cars. On an average, such a train would carry about 800 tons of revenue-making freight. At Tabernash, on the west side below Rollins Pass, is located an engine-changing station. From that point eastward to Denver—a distance of less than 90 miles—the running time of a loaded 22-car freight train is not infrequently anywhere from 14 to 16 hours. This situation speaks for itself and reveals how slow the progress is and how inadequate the service, and mainly because of physical conditions.

Without embarking upon a mathematical explanation of the factors and the forces involved in climbing a steep hill and in turning sharp and long curves, it will suffice to say that the big Mallet locomotives are taxed well-nigh to their utmost in ascending the 4 per cent. grades that prevail for miles on the slopes adjacent to the crest of Rollins Pass. The grades and the curves exert a drag which, in effect, is equivalent to adding considerably to the total weight of a train. It can now readily be understood why Moffat wanted to tunnel through the Continental Divide when his road was first started. In fact, he never abandoned hope of building the tunnel which he originally deemed essential to the proper development of his project; and he was seeking money for that purpose when he died in New York City on March 18, 1911, in his 72nd year.

So far, the Moffat Railroad and an interposed tunnel have been considered principally in their actual and potential relations to Colorado and Denver, but they should also be recognized as undertakings which promise to be of nationwide benefit. The tunnel will constitute a channel by which the vast natural resources of western Colorado and eastern Utah can flow to ready markets in the populous valley of the Mississippi River; and the tunnel will further make it practicable to save nearly 200 miles of travel and thus speed up transcontinental traffic. The average citizen will probably wonder why there has been so much delay in driving this economically desirable tunnel. The main reason has been the difficulty heretofore encountered in getting the capital needed to carry out an undertaking of such monumental proportions. Further, Colorado was for years divided against itself on this question: some parts of the state being earnestly opposed while other sections were equally active in their advocacy of the scheme.

David H. Moffat, who was born in Orange County, N. Y., in 1839 and died in New York City in 1911, became a resident of Denver in 1860. From then onward he was intimately associated not only with the development of Denver, but of Colorado, as a whole.

Prior to 1913, private enterprise inspired the negotiations for funds for the building of a tunnel through the Divide immediately west of Denver; but in the spring of 1913 the people of Denver took hold of the project and voted an amendment to the city charter and thereby created a Moffat Tunnel Commission. The commission was authorized by the voters to issue municipal bonds to the amount of $3,000,000; and a contract was prepared and signed by which Denver and the Moffat Railroad jointly pledged themselves to construct the long desired tunnel. Unfortunately, the state constitution prohibits a municipality from lending credit to a private corporation; and, as a result of a taxpayers' suit, the Supreme Court of Colorado declared the tunnel bond issue invalid. This action served to arouse the tunnel advocates to still greater effort; and William G. Evans, then chairman of the State Railroad Commission, assumed the leadership in this matter that "Dave" Moffat had formerly exercised.

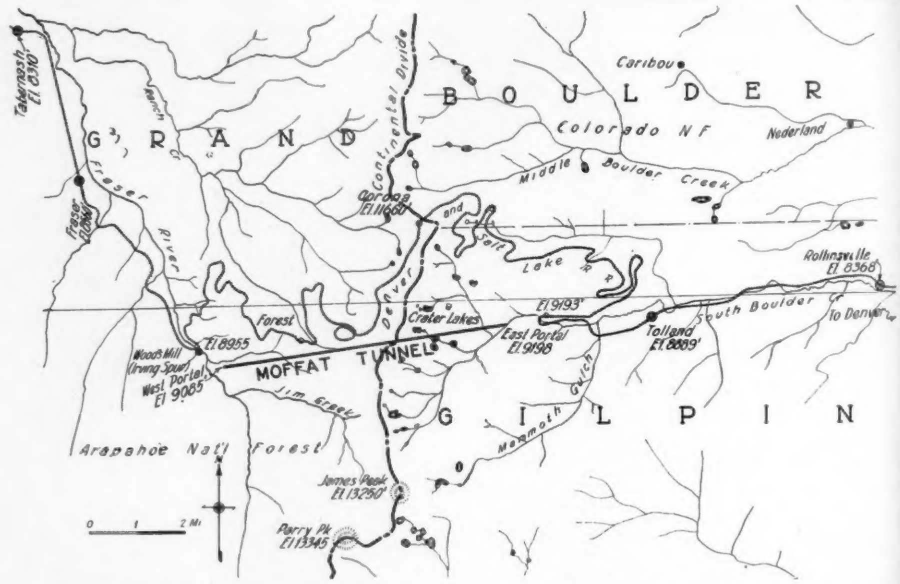
At the general election, in November of 1920, the voters of the state were asked to vote upon what was called the Tri-Tunnel Proposition which involved a state bond issue totaling $18,550,000. This plan was intended to win the approval of all sections of Colorado and contemplated the driving of three tunnels through the Continental Divide: one near James Peak on the Moffat line; one at Monarch Pass on the Denver & Rio Grande Western; and a third at Cumbres or Wolf Creek on the Rio Grande Southern—the work to be carried on simultaneously at the three points. The tunnels were to be forever the property of the state. This measure was defeated by a narrow margin—the citizenry of Pueblo being strongly united against it.

Two years later, Pueblo suffered tremendously during a flood period of the Arkansas River, and a special session of the legislature was called

in April of 1922 to consider flood protection for the stricken city. As a result of her predicament and the need of state aid, Pueblo withdrew her opposition to the tunneling of the Continental Divide. Therefore, a bill was then introduced having for its purpose the creating of the Moffat Tunnel District, and this bill was passed by the legislature and subsequently signed by the Governor on May 20, following. The Governor appointed five tunnel commissioners: W. P. Robinson, W. N. W. Blayney, Charles M. Willcox, Charles H. Leckenby, and Charles Wheeler. Mr. Robinson was elected president of the commission; and in due season Mr. R. H. Keays, who had been in charge of the construction of the great Shandaken Tunnel in New York State, was appointed chief engineer.

After a taxpayers' suit, which was decided successively in favor of the undertaking by the Supreme Court of Colorado and by the Supreme Court of the United States—the decision of the latter being announced on June 11, 1923, the commission was free to proceed with the issuance of bonds to the amount of $6,720,000 as authorized by the state legislature. The enabling act specified: "The said tunnel, its approaches, equipment, and appurtenances, shall be owned perpetually by the Moffat Tunnel Improvement District, and shall remain forever a public improvement for public transportation and communication. There shall be no monopoly of the use of said tunnel and its approaches by any one use, or by any person or corporation, private or public."

Immediately following the action of the United States Supreme Court, the commissioners were empowered to go ahead in carrying out the plan initiated in principle by David Moffat more than a score of years



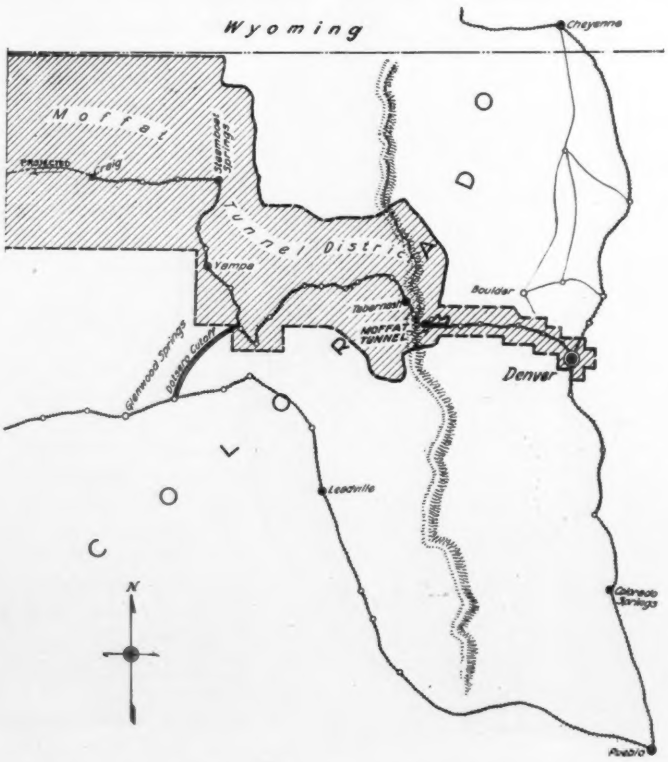
The straight line of the Moffat Tunnel is in striking contrast to the looping, twisting route by which the Denver & Salt Lake Railroad now traces its way over the mountains to the west of Denver.

previously. After advertising for bids, a contract for driving the tunnel was awarded to Hitchcock-Tinkler, Inc., a nationally known construction firm, at a basic price of $5,250,000. The contract for this momentous undertaking was signed on September 19, 1923.

The tunnel will be 6.09 miles in length between portals, will shorten the run across the Continental Divide by 23 miles, and lower the climb by 2,406 feet. The steepest grades will not exceed 2 per cent., and a single large locomotive will be able to pull a 22-car freight train from Tabernash to Denver at twice the speed now possible with four engines. Furthermore, the approaches to the new route will be far enough below timberline to be out of the way of the worst of the drifti snows that have hitherto so seriously ham pered traffic during the wintertime. Repea edly, the great rotary snow plows and th locomotives have been obliged to battle wi snow drifts as much as 18 to 25 feet in dept

At the present time, trains bound fro Dotsero, Colo., to Denver by way of the De ver & Rio Grande Western Railroad mu follow a circuitous route 174 miles lon Dotsero is actually only 42 miles to the sou and west of a neighboring point on the De ver & Salt Lake Railroad. It is therefo proposed that the interested roads constru a connecting cut-off so as to enable th Denver & Rio Grande Western to utilize th Moffat Tunnel and thus to save time a something like $1,000,000 annually in ope ating expense.

(To be continued).



This map makes plain how Denver lies off from the main lines of the tributary transcontinental railways; and it also illustrates the changes that can be brought about by the building of the Dotsero cut-off and the completion of the Moffat Tunnel.

SPECIFIC VOLUME OF AMMONIA VAPOR

A KNOWLEDGE of the specific volume ammonia vapor—which, in the fo pound system of units, is the number of c bic feet occupied by one pound of ammo vapor—is useful to the refrigerating engine for calculating the size of ammonia co pressors and of pipe lines necessary for t production of ice or for refrigeration a desired rate.

In an investigation recently conducted the United States Bureau of Standards, t specific volume of pure superheated ammo vapor was measured with an accuracy of part to 1,000, or better, by weighing t amount of ammonia at various temperatu and pressures required to fill a container known capacity. A temperature range of fr -31 to $+572°$F. was covered, and a press range of from 1 to 30 atmospheres.

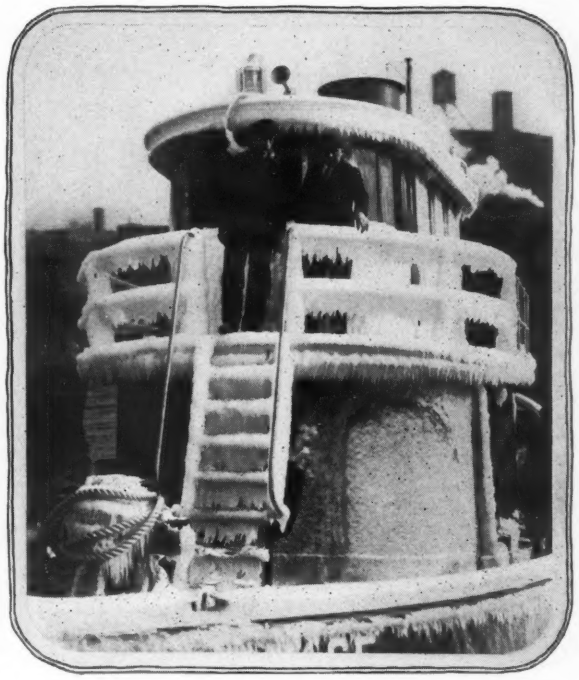
Although the range and the accuracy a somewhat in excess of the present engineeri requirements, history has shown that expe mental data which meet only the demands the day must soon be redetermined.

Something New in Oil-Engine-Driven Tugs

By A. S. TAYLOR

THE tugboat is the general utility craft of water-borne traffic. One has only to take a casual glimpse of any busy harbor to get a striking object lesson of how much the movement of shipping is dependent upon these sturdy pushing and pulling boats. Barges, lighters, and the like are shifted from point to point in the ceaseless transfer of commodities from pier to pier and from ship to railroad, or *vice versa*. Not only that, the overtopping, self-sufficient steamship becomes suddenly impotent when about to enter or to leave her slip. The tug swings the ocean-going vessel about so that she may be properly docked in a tideway or slews the big ship around so that she may be headed right in the channel where she can safely take over the work of her own propulsion.

This summary of the services performed by the hustling, handy tug gives but an imperfect idea of its manysided usefulness. It is only when a person becomes familiar with the waterfront activities of a busy port that he is able to appreciate how often a tug is needed and how skilfully she must be maneuvered to do aright the things expected of her. There are many things that go into the get-up of a tug that either make or mar her fitness for her particular field of employment; but above all she must be promptly responsive to her helm and quick in acquiring steerageway whether moving ahead or astern. This is all by way of prelude to a description of the oil-engine-driven tug *Grace,* recently added to the harbor facilities in Greater New York of the well-known steamship line owned and operated by W. R. Grace & Company. The fine vessels composing the fleet ply between the Port of New York and ports on the Pacific coast of South America.



© Pacific & Atlantic Photos, Inc.

When the "Grace" reached New York after her run northward from Baltimore she was covered with many tons of frozen spray.

The *Grace* was built at the yard of The Spedden Shipbuilding Company in Baltimore, Md., and made the run from Baltimore to New York during the last days of December just gone. The trip northward proved a decidedly interesting one inasmuch as it not only subjected the little craft to a very severe test but it brought to light certain qualities which had not previously been given special consideration—all of them admirable in their several ways.

Before telling the story of the run of approximately 200 miles, it might be well to mention the boat's principal dimensions and some of her outstanding characteristics. These are as follows:

Length, overall	76 ft.
Length, on load water line	72 ft. 9 ins.
Beam	19 ft.
Depth, molded	9 ft. 9 ins.
Draft, mean, about	8 ft.
Speed, maximum, on measured course	11¼ miles

The *Grace* is propelled by an Ingersoll-Rand oil engine rated at 320 H.P. This 6-cylinder solid-injection engine is of a type which has proved highly efficient and very satisfactory in other tugboats; and because of this record the unit in question was chosen for the *Grace*. The complement of the tug consists of five men—the captain, an engineer, an oiler, and two deckhands. Comfortable accommodations are provided aboard for this personnel. Now for an account of the trip northward from Baltimore.

Duly provisioned and with her fuel tanks

Tugboat "Grace" helping to swing an outward-bound liner into the channel fairway.

Tugboat service demands ease of maneuvering and the capacity to pick up speed quickly when moving either ahead or astern. This boat has proved unusually responsive because of her oil-engine drive.

filled, the *Grace* left Baltimore at 6 o'clock in the morning of Saturday, December 27. In order to avoid the long run southward to the capes of the Chesapeake, it was decided to follow an inland course as far as possible. Therefore, the craft was headed northward and eastward through the upper reaches of Chesapeake Bay and thence into the Delaware and Chesapeake Canal. Before the boat reached the eastern outlet of the canal at Delaware City she was obliged to break her way for something like 50 miles through ice which attained a maximum thickness of 7 inches. This ice was sufficiently heavy to hold up the movement of a number of vessels regularly engaged in traffic through the canal. However, the *Grace* forged ahead without cease—thus putting her steel hull and her motive power to a rigorous test. Had the trip been scheduled for the mild months, the tug would have gone on to New York Bay by the intracoastal route. Unfortunately, ice in the Delaware and Raritan Canal had led to the closing of that waterway to further traffic, and the *Grace* was, therefore, obliged to go down the Delaware River and out into the Atlantic.

The outside run from Cape May northward was a rough one. Once clear of the comparatively sheltered waters of Delaware Bay, the boat was exposed to the untempered sweep of a very strong northwesterly wind which had kicked up a heavy head sea into which the little vessel had to nose. The Atlantic was in an angry mood, and the waves were high and followed fast. Even so, the *Grace* amply proved her weatherliness and was surprisingly easy in her motions. Not only was she compelled to buck head seas but to face a wind that was bitterly cold. The flying salt spray froze quickly, coating the tug with ice from stem to stern. In fact, it was at this very time that large ocean-going steamers were late in reaching American ports because of the prevailing bad weather. When the *Grace* reached her destination at 2.30 P. M. on Sunday, December 28, she was covered with ice representing an added dead weight of more than twelve tons. During the entire passage from Baltimore to New York the machinery gave perfect satisfaction, and both the captain and the engineer have been consistently loud in their praise of the craft's performance.

Most small tugs are maneuvered by a hand wheel. This operation becomes wearisome and at times exhausting in the course of a long and busy day. The *Grace* differs from other towboats in this respect: her steering gear is driven by a reversible air motor, and her navigator has only to swing a horizontal lever which opens and closes the compressed air throttle and incidentally controls the direction in which the motor moves. When one recalls the many maneuvers made by a tug while engaged about a busy waterfront it will be easy to evaluate the meaning of this labor-saving equipment. Further, the air-driven gear is able to swing the rudder from side to side faster than it ordinarily can be done by hand, and then only at an expenditure of much effort.

It might be emphasized here that the control of the rudder is in keeping with the ease with which the *Grace* can be given steerageway either ahead or astern. For some unaccountable reason the belief persists among some members of the shipping fraternity that an oil engine is slower than a steam engine in responding to the throttle, and they argue that the oil engine is therefore not so well adapted to tugboat service. This is erroneous.

In the case of the *Grace*, for instance, the control of the engine is fully as flexible as would be that of a steam engine in the same place. That is to say, the vessel can be given headway or sternway at speeds agreeably to every demand, and because of this she can be eased nicely into or out of a crowded slip or made to thread her way in safety amid a congestion of shipping. Further, when the jingle bell is sounded for full speed either ahead or astern, the *Grace* attains a maximum movement quicker than would be practicable with a steam engine of similar power in a boat of the same size and model.

According to the captain of the *Grace*, the engineer can make the boat fairly jump by opening the throttle wide. This indicates the efficiency of the propeller with which the tug is fitted as well as the power delivered to the shaft by the oil engine and the quickness with which the prime mover reaches full speed. In brief, the oil engine is anything but slow in its action during maneuvering periods calling for frequent reversals or changes of speed. In the short time the *Grace* has been in service she has amply demonstrated her excellent and, in some respects, her unique qualifications.

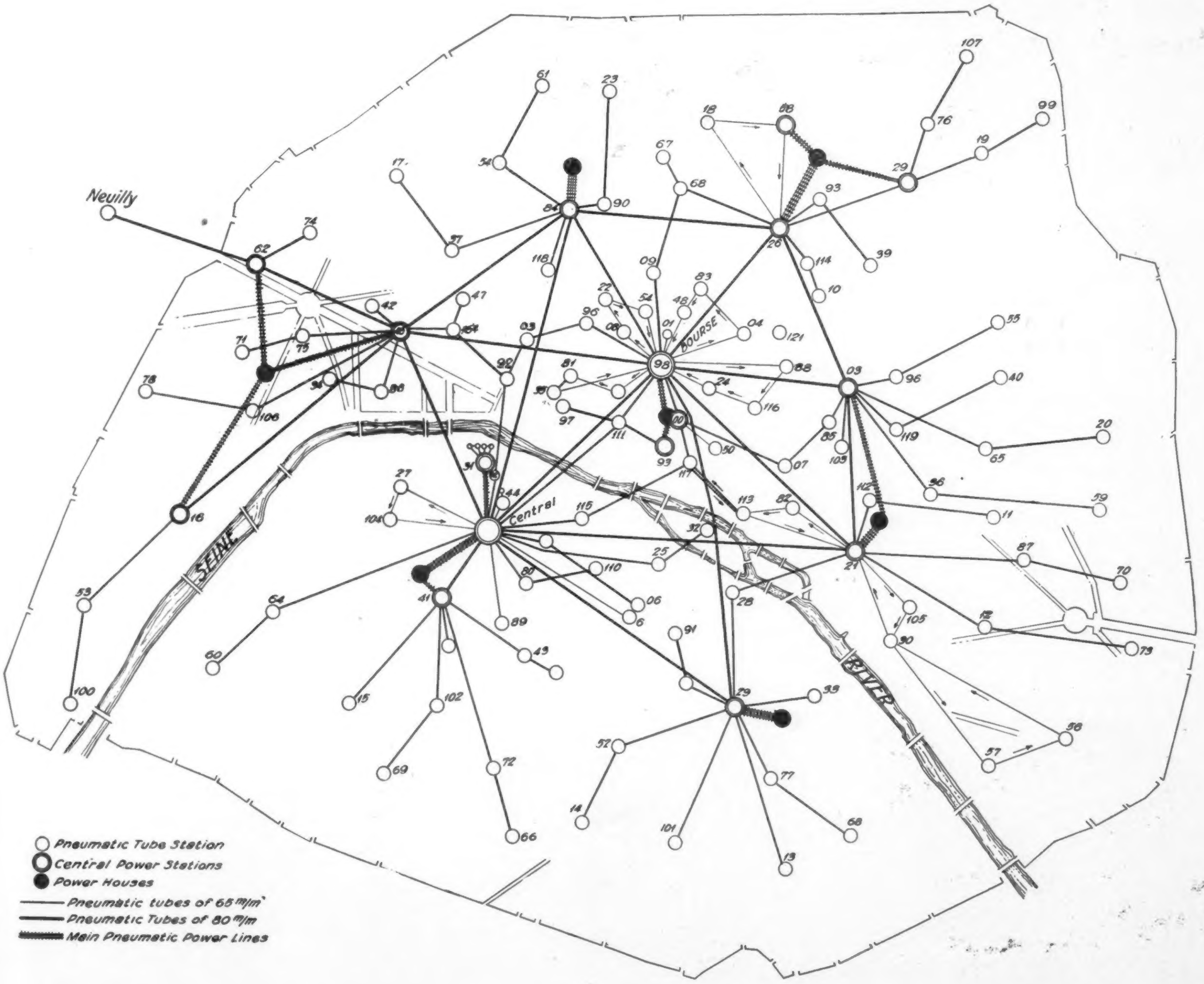
Although but a short while in service, this oil-engine-driven tug has shown herself to be remarkably easy to handle.

Paris Has Reason to be Proud of Her Pneumatic Mail-Tube System

By BEN K. RALEIGH and A. M. HOFFMANN

PARIS is rightfully boastful of her air—her sparkling, refreshing air. This is, of course, above ground. But below ground, she is also a city of air—compressed air, ready to do man's bidding. In short, Paris is the only place in the world where compressed air is a public utility like gas, electricity, and steam: where compressed air is carried from one end of the metropolis to the other in a vast network of piping, beneath the city streets, to do a multiplicity of services. However, we cannot enter into all of these here, and will therefore take up only the subject of the far-flung pneumatic postal service that draws generously on the propulsive power thus provided.

A glance at the accompanying map will show that this system of mail transmission extends not only from the hub into every quarter of Paris but that numerous substations throughout the city make it possible to send mail direct or to relay it from one point to another. In short, every section of Paris—whether it be given over to business or homes—is within easy reach of one of these pneumatic-tube stations.



In order to bring out clearly how interconnected the system is let us briefly consider one of the intermediate stations, No. 29, for example, in the lower right-hand corner of the map. This station is linked immediately with one of the seven power plants that supplies compressed air for the operation of the pneumatic tubes as well as for distribution throughout the service mains previously referred to. First of all, No. 29 is in direct communication with the two main stations, *Central* and *Bourse* and, like the spokes of a wheel, reaches out to the lesser branches Nos. 38, 91, 52, 14, 101, 13, 77, 68, 33, and 28. Thence, by way of No. 28, it is in touch with No. 21—another intermediate station serving a zone of approximately the same area.

As developed, the system readily lends itself to expansion. This is exemplified in the case of the tubes that have been run out to the suburbs of Neuilly-sur-Seine and to Pantin, the latter lying to the northeast and not included in the system when the map was made. So far these are the only districts beyond the city limits to enjoy the advantages offered by this special mail service; but if a scheme now under consideration is carried to conclusion then even London will be benefited.

Business men in both the French and the English capitals are very much interested in a proposition before the French Chamber of Deputies that has for its purpose the hastening of mail in transit between Paris and London, or *vice versa*. The plan is to extend the

The Paris Bourse, seen at the left, is one of the main stations of the pneumatic mail-tube system.

tube from Pantin to the great aviation field at Le Bourget, not far away—in other words, to carry all letters destined for London first by way of the pneumatic system to Le Bourget and thence by airplane across the Channel. It is argued that a letter mailed in Paris in the morning would thus not only reach London from two to three hours later but that an answer thereto could be received at any address in Paris and its immediate environs before 6 o'clock on the same day. This would mean cutting down the time of postal matter in transit between these two cities from 2½ days to 1 day. Of course, this could be done only if the mail were similarly handled at both ends of the line.

The advantages of such a rapid transmission of first-class mail are too obvious to require elaboration here. Locally, the pneumatic tubes render valuable service industrially as well as socially; and in cases where time is pressing and where a written record of a transaction or an agreement is required the system meets a demand that neither the telephone nor the telegraph can fill. To send a *pneumatique* or a *petit-bleu*—as the messages dispatched by means of compressed air are called—costs 60 centimes. At the normal rate of exchange there are 19.3 francs to a dollar.

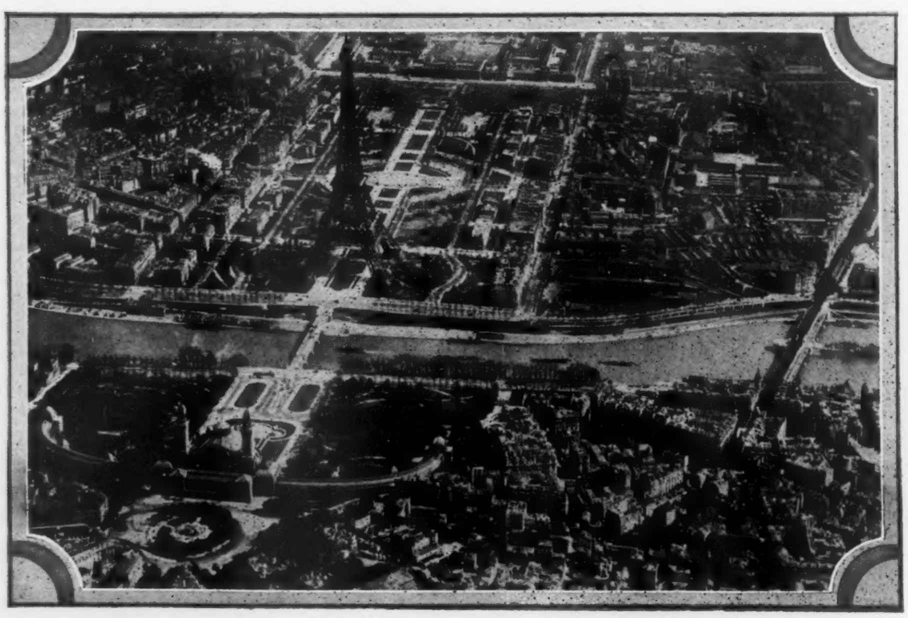
Perhaps we can make plainer the superiority of the pneumatic system over other means of communication within a metropolis like Paris. Not so long ago, a Parisian, specially desirous of reaching a correspondent in the city, decided to try out competitively the different means of transmission. He describes his experience as follows: "I dropped a *petit bleu* into one of the boxes set apart for *pneumatiques,* such as are found in all the postal stations in Paris. At the same moment my companion filed a telegram for the same destination in the same office. We then took a taxicab and drove to the address to which we had sent the *pneumatique* and the telegram. Congestion of traffic along the way held us up a little. When we reached the appointed place at the other side of the city we were handed the *petit bleu* by our friend who had received it within 35 minutes after its dispatch. In other words, the pneumatic service beat our taxicab by 10 minutes. The telegram was not delivered until half an hour later."

As far back as 1865, attempts were made in Paris to speed up the carriage of certain classes of mail matter, packed in suitable containers, by forcing them by air pressure through underground conduits. So successful were those experiments that within a year pneumatic tubes were in operation between the general post office and stations at the *Bourse,* or stock exchange, and Boulevard Capucines. Ten years later there was a total of 46 stations, of which 17 were in direct communication with the *Central* while 29 were served indirectly. However, the foundation, so to speak, of the present system was not laid until August of 1867, when it was decided to develop the plant on the polygonal principle. This means that all the pneumatic stations are interconnected and linked to the main station—the course traveled by the carriers forming the sides of a polygon. By this arrangement the movement of mail is always in one direction.

Gradually, the service was extended in this fashion until, today, a vast network of about 311 miles of pneumatic tubes conveys thousands of letters and telegrams hither and thither daily into every quarter of Paris. *Pneumatiques* are accepted for delivery from 7 a. m. to 9 p. m., but during the night the tubes are used for the sole purpose of distributing telegrams. As a matter of fact, the telegraph office and the postal department work hand in hand—that is, all outgoing telegrams or cables reach the central telegraph office by way of the pneumatic tubes, or they are thus sent to the post offices nearest their destinations.

As can readily be appreciated, the two main stations are the busiest ones and handle daily about 29,000 pieces of mail each, or an average of 2,071 per hour. During the rush period as high as 3,000 letters are dispatched every 60 minutes. These are transported in what are called "omnibus trains," made up of one carrier piston and two cylindrical containers, which are sent from the main stations at 3-minute intervals. Each container has a capacity of 100 letters. Every one of the smaller branches, removed from the center of activities, takes care of about 600 communications a day. Considering the number of pneumatic-tube stations, these figures give us an idea of the magnitude of the service.

It might be of interest to mention here that



How a part of Paris appears from an airship. The River Seine is seen in the middle distance with the Eiffel Tower rising just beyond it.

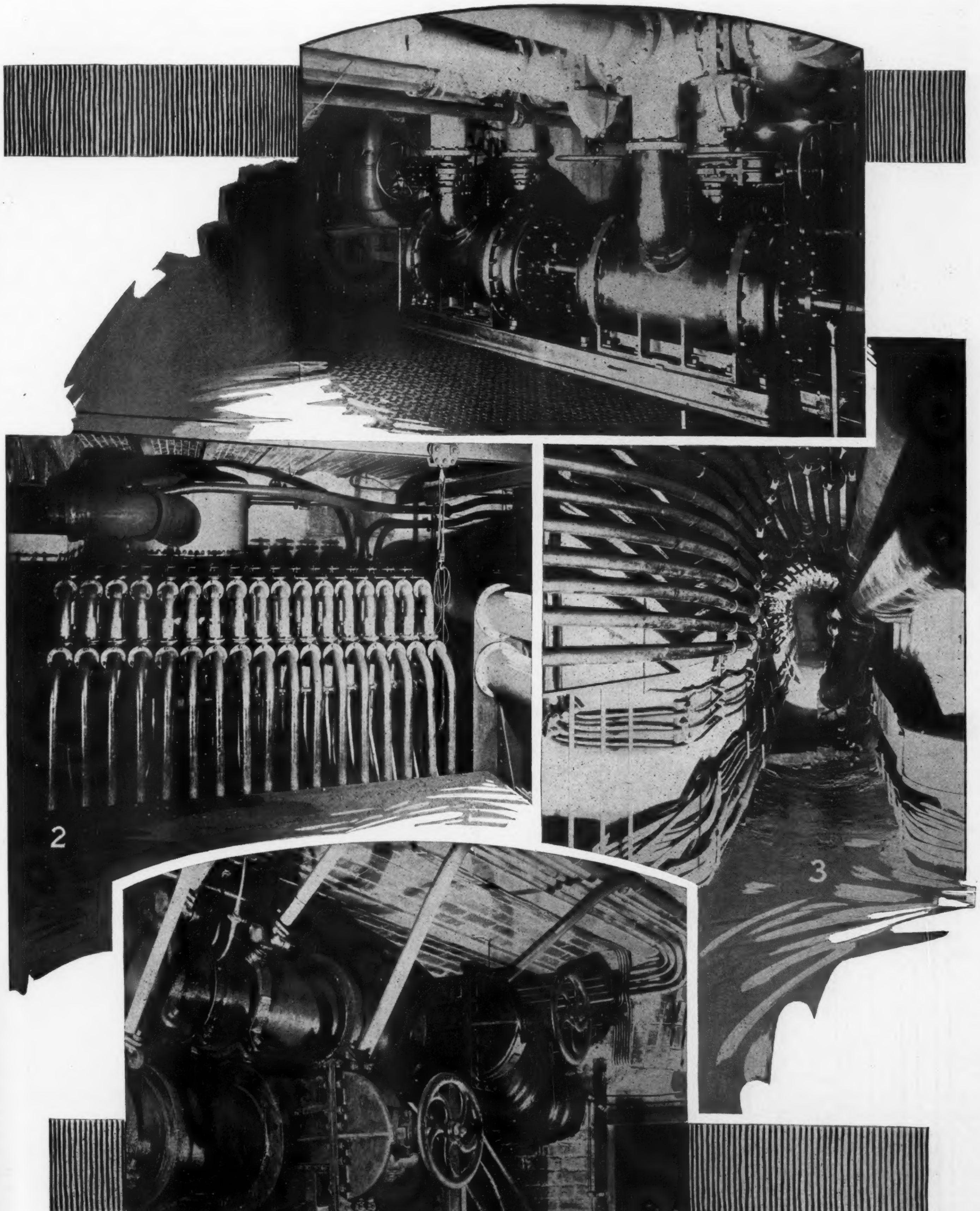
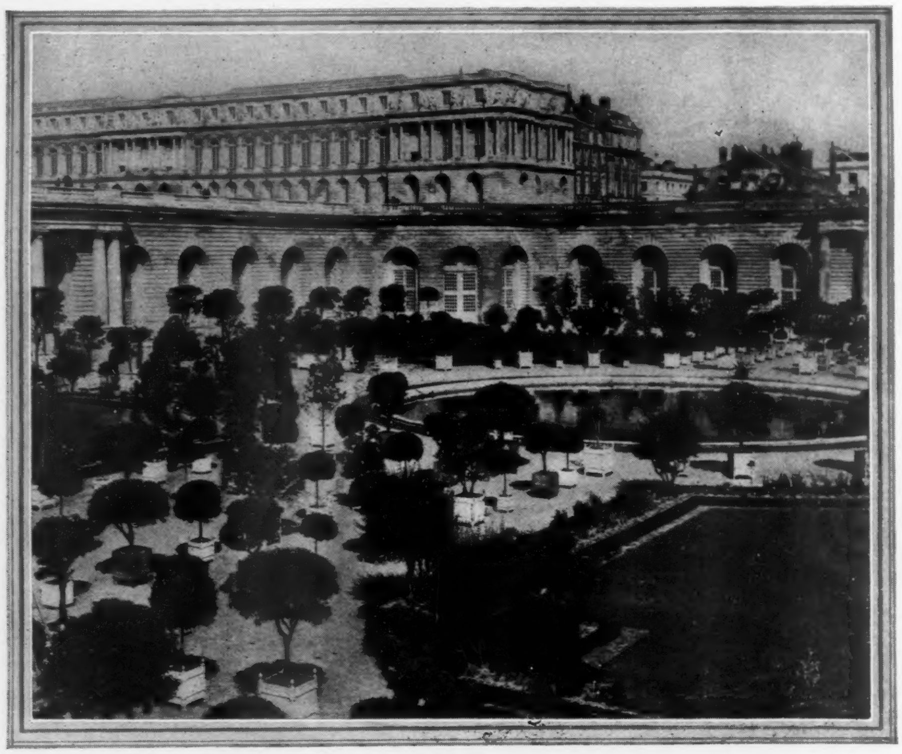


Fig. 1—In the engine-room of one of the Paris power houses where are installed both air compressors and vacuum pumps.
Fig. 2—A group of 2.65-inch tubes constituting part of the distributing equipment of the pneumatic system in the Paris Bourse.
Fig. 3—One of the passageways under the Bourse through which the compressed air and the suction lines are led to this important pneumatic station.
Fig. 4—A close-up of the large valves inserted in the piping of the pneumatic system at one of the principal stations.



A glimpse of the beautiful Versailles Palace.

the 300-odd miles of tubes, which have an inside diameter of either 80 or 65 mm. (3.15 or 2.65 inches) are run through sewers, thus greatly facilitating the work of repair. In other words, the arrangement obviates tearing up the streets to do any necessary overhauling. The Paris sewers are very accessible, and permit a man to stand in them upright.

The system now utilized in Paris was devised by M. Gissot, a prominent official of the Department of Posts and Telegraphs. It is a distinct improvement upon the older installation both in flexibility of service and in the employment of lighter working parts. As a matter of fact, the system can be operated in four different ways: First, by the use of compressed air applied to the system as a whole; second, by the use of vacuum applied to the system as a whole; third, by the use of a combination of the two, that is, by the action of compressed air at the rear of a train supplemented by a vacuum induced in front of a train; and, fourth, by applying compressed air at the rear of a train and by reducing the resistance ahead of a train by permitting the escape of the air ahead of the train at an intermediate point.

The manner of operating the system is illustrated diagrammatically. Fig. 1 shows the system at rest; Fig. 2 indicates the working cycle when under compression; and Fig. 3 deals with the conditions brought about by recourse to vacuum. To be specific, according to Fig. 1, the turning of the twin cocks, g and f, causes the vacuum to exert itself beneath the pistons of the distributors, Dv and Dp, which are held in equilibrium because of the force derived from the reservoir. The head, T, of the apparatus is put in communication with the atmosphere by means of the intermediate tube, t—discharge from the reservoir being cut off the while.

In order to dispatch a tube train by means of compressed air, as shown in Fig. 2, the carriers or mail cylinders are placed in the head of the apparatus and the valve, j, of one of the twin cocks is turned so as to cause air pressure to act under the piston of the distributor Dp. This raises Dp and cuts off communication with the atmosphere through the head of the apparatus and simultaneously allows compressed air to flow from the reservoir. Compressed air thus acts upon the train P. Further, by manipulating valve, k, vacuum is brought into play forward of the carrier while compressed air is acting behind it.

Fig. 3 illustrates the manner in which vacuum is mainly utilized to advance a train. That is to say, the mail cylinders are first started by an impulse of compressed air applied behind them, after which the compressed air is shut off and vacuum is induced ahead of the train—advance being accelerated by the admission of atmospheric air into the tube to the rear of the train.

Realizing as the reader must that these pneumatic postal trains travel at considerable speed, it is natural for him to ask: "How are these trains slowed down and brought to a standstill so that they will not harm themselves or the terminal equipment of the tubes?" This necessary action is effected through the agency of suitable braking apparatus inserted at certain points. This is merely added evidence of the care that has been exercised in the development of the system to insure its satisfactory working under all conditions. Needless to remark, much thought and much engineering skill has been drawn upon to produce the everyday efficient results which characterize the operation of the Paris pneumatic postal installation.

In the preparation of this article, valuable material and illustrations have been graciously furnished by officials of the Department of Posts, Telegraphs, and Telephones of the French Government.

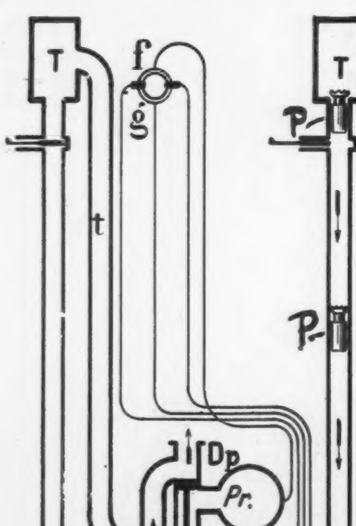


Fig. 1.

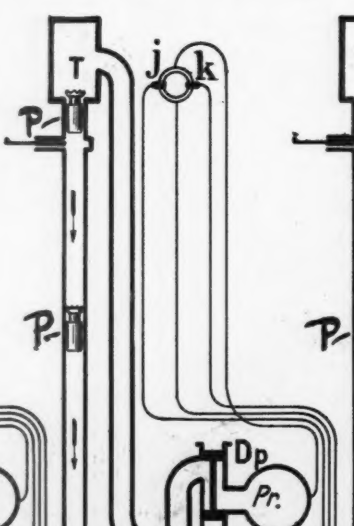


Fig. 2.

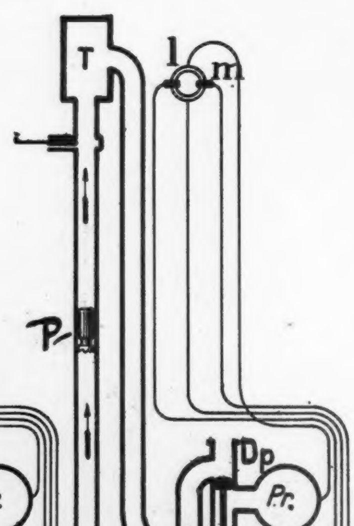


Fig. 3.

GROWTH OF FLYING HABIT

IT IS becoming a common occurrence for mining men to use the airplane for trips between mining camps in the interior of Alaska and also in northwestern Canada. Norman L. Wimmler, placer mining engineer of the United States Bureau of Mines, recently flew from Fairbanks, Alaska, to Eagle, an air-line distance of about 200 miles, in less than three hours. Two modern airships now make regular trips out of Fairbanks—thus bringing that center within a few hours' travel of Tolovana, Kantishna, Salaha, Circle City, and other mining districts on the Yukon.

Sea Gull Sanctuary of Great Salt Lake

SOMEHOW the gull is well-nigh exclusively associated in the minds of most of us either with the open sea or with those coasts where the pounding surf booms continually. To such, it is ever a source of wonderment whence come the gulls that are not infrequently found round inland waters removed, perhaps, hundreds of miles from the ocean. The gulls that frequent Great Salt Lake, Utah, are a picturesque phenomenon of this sort. And their presence there is made still more puzzling when the visitor is told that those briny waters are virtually devoid of aquatic life capable of sustaining the gulls which gather thereabouts by thousands during the mild or warm months every year. These birds, which winter on the coast of California 600 miles away, journey at the turn of the season over the high intervening mountains to Great Salt Lake and especially to a single island in that lake where they propagate their kind.

It is a curious fact that these gulls have so adapted their habits to their inland environment that they live, so to speak, almost entirely upon the land while sojourning in Utah. How long they have been doing this is not known; but their arrival one year unquestionably proved little less than a godsend to the Mormons. There now stands in the Temple grounds in Salt Lake City a beautiful monument, commemorative of this incident, bearing the following inscription: "Erected in grateful remembrance of the mercy of God to the Mormon pioneers."

It was in 1847 that Brigham Young and 143 of his associates emerged from Emigration Canyon in the Wasatch Mountains and looked down upon a rather sterile valley which Mormon industry soon began to turn into "a land of milk and honey." But at the very start these pioneers faced impending starvation because of the ravages of insects which attacked the first of their crops of grain. The Mormons had carried the precious seed with them on their long journey westward; and this wheat and corn had been carefully guarded as they meant so much towards the success of their venture into the wilderness. The story is thus told by a citizen of Utah:

"Black crickets came down by millions and destroyed our crops; what were promising fields of wheat in the morning were as smooth as a man's hand by night because of these pests. At this juncture sea gulls came by hundreds and thousands, and before the crops were entirely destroyed these gulls devoured the insects, so that our fields were entirely freed from them. The settlers at Salt Lake regarded the advent of the birds as a heaven-sent miracle."

Today, these gulls visit cultivated fields where they pick up grubs, grasshoppers, and other insects. When unmolested they become fairly fearless and follow right after the plowman, eating greedily of worms and other forms of animal life to be found in newly turned furrows. Just how helpful these winged scavangers are has been made plain on numerous occasions by examining the stomach contents of the gulls; and it is surprising how many destructive insects a gull will eat in the course of a day. For instance in the stomach of a single bird have been found 70 entire grasshoppers and the jaws of 56 others, not to mention the remains of numerous crickets. The grasshopper is the most important item of animal food among gulls during a large part of the time the birds are in the neighborhood of Great Salt Lake. That is to say, grasshoppers constitute anywhere from 43 to 80 per cent. of the whole diet for many weeks running.

On the shores of Great Salt Lake are several big industrial plants, and when the noon whistles blow the sea gulls wing their way

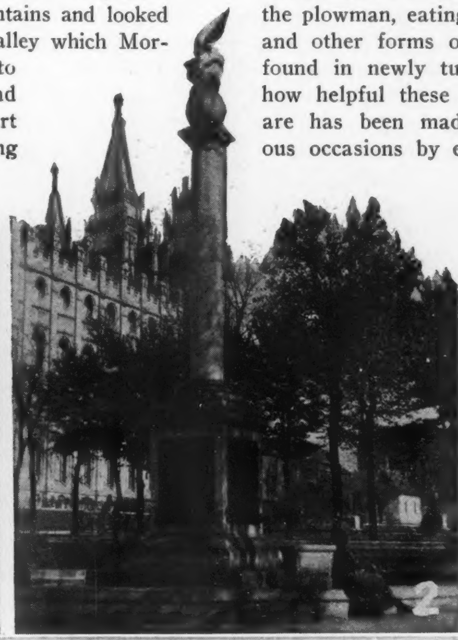


Fig. 1—Looking eastward over a part of Salt Lake City toward the Wasatch Mountains.
Fig. 2—Sea gull monument in the Temple grounds of Salt Lake City.
Fig. 3—Eagle gate looking north on State Street toward the capitol.
Fig. 4—Monument erected at point where the Mormons, coming through the pass at the rear, first saw Great Salt Lake and the valley where they settled in Utah.

Near view of the domestic life of the sea gulls of Great Salt Lake during the breeding season.

to these places—having learned by experience that the workmen will leave scraps of food scattered about at the conclusion of the lunch hour. The interesting aspect of this acquired habit is that the gulls do not fly to the plants until they hear the sound of the whistles. The gulls make a very effective clean-up of everything edible.

One of the accompanying illustrations is a close-up of a section of the breeding grounds on Bird Island, and shows a fledgling gull. This sanctuary is generally secure from intrusion, and has been used by the gulls for a long while. These birds do not belong to the species of gulls and terns that are to be seen about bodies of fresh water elsewhere in America.

BOLL WEEVIL LIKES FISH

DOCTOR Power, of the United States Bureau of Chemistry, is certainly finding out things about the boll weevil. While carefully analyzing the cotton plant he has discovered that it contains, among other substances, trimethylamine, a non-poisonous material that has long had an unsavory reputation because of its strong fishy odor. It is trimethylamine the weevil is after.

This colorless alkaline liquid, which is obtained in large quantities from herring brine, has latterly been used with gratifying results in connection with boll-weevil research work at the Delta Experiment Station of the Bureau of Entomology. It was learned that by placing trimethylamine on neighboring foliage the weevil would actually leave the cotton plant—thus suggesting, as it has been said, "an easy means for its ultimate destruction."

CEMENT GUN USED TO BUILD SILOS IN AUSTRIA

GUNITE is steadily growing in favor as a building material by reason of the facility with which it can be applied by the aid of compressed air. In Austria, where conditions have enforced economies in every possible direction, gunite is now being used in the construction of silos by the firm of Prokop, Lutz & Wallner of St. Poelten.

As the accompanying illustration shows, the circular body of the silo, which rests on a concrete foundation, consists of latticework made up of three layers of narrow wooden laths. This structure is then given a ¾-inch coating of gunite, both inside and outside, by means of the cement gun. The resulting walls are thoroughly airtight, something quite essential to the preservation of green fodder. A silo of this type, with a capacity of 78 cubic yards, can be completed in 5 days and at about one-third the cost of a concrete or tile structure of the same size.

Building silos with gunite in Austria.

ELECTRO-PNEUMATIC DOORS INCREASE SAFETY

FROM the viewpoint of safety as well as economy, the substitution of electro-pneumatic doors for hand-operated doors on the subway cars of New York City has been entirely satisfactory, so it has recently been announced by the Interborough Rapid Transit Company.

Since 1920, when the new control system was first demonstrated, 1,477 cars have been modified by this new equipment at a total outlay of $4,300,000. In other words, at the end of last year, there remained but 558 cars on the line still to be provided with electro-pneumatic doors. According to officials of the Interborough Rapid Transit Company, "The new electro-pneumatic doors have been found to be five times safer than the older type of hand-operated doors. This statement is based on carefully compiled figures covering records of the operation of cars of both types. On cars equipped with the pneumatic type of doors there was one door accident for every 606,123 passengers carried during the first eight months of 1924, whereas there was one door accident for every 119,117 passengers carried in the same interval in cars with hand-operated doors."

From the time the subway was opened in 1904 until the adoption of the pneumatic doors it was the practice for a guard stationed between every two cars to operate the two adjacent end doors by means of hand levers. Later, when doors were also placed in the middle of a car to facilitate the movement of traffic, the guard likewise had to work the center side door of the car behind him. There were several objections to this. Apart from safety, the functioning of the three levers called for considerable strength on the part of the attendant; and the speed of opening and of closing the doors depended upon the energy he applied.

Now, with the pneumatic multiple-unit door-control system, the guard stands on steps built on the outside ends of the cars where he has a clear view of the station platform and of the passengers. Instead of three levers to operate and to distract his attention he simply has to press a button to either open or shut the doors under his supervision.

When all doors are closed and thus automatically locked, a light glows in the motorman's cab and signals him that it is safe to go ahead. Should any one door of a train remain open just half an inch, a red warning light indicates that fact to the guard—in other words, it is not until all the warning lights are extinguished, all the doors securely shut, that the motorman gets his starting signal.

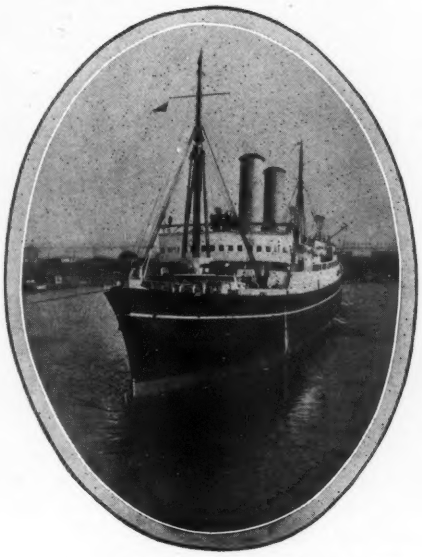
America's Second Largest Seaport

Such is the Position Now Enjoyed by Montreal which Stands Preeminent as a Grain-Handling Center

By F. A. McLEAN

THE RAPID rise of Canada during the last two decades as a power in international trade has necessitated the expenditure of vast sums of money for the improvement of harbors on the Atlantic and the Pacific coasts as well as on the Great Lakes; for the dredging and deepening of waterways; and for the construction of immense grain-handling plants, wharves, warehouses, cold-storage plants, etc.

In cutting costs and in speeding up the construction of public works of this character, compressed air has played a very important part. Air-driven drills, wood borers, riveting hammers, drift-bolt drivers, and other pneumatic tools have brought about such important savings that they are now considered an essential part of the equipment used by contractors and government engineers engaged in this kind of work. To tell what Canada has done to enlarge and to improve her various canals as well as her harbors at Halifax, St. John, Fort William, Vancouver, and other ports would take up too much space. We will therefore confine ourselves in this article to a description of her largest port, Montreal—incidentally bringing out some of the reasons for the Dominion's phenomenal rise as a figure in world trade.



© Canadian Pacific Railway.
Large sea-going liner docking at Montreal.

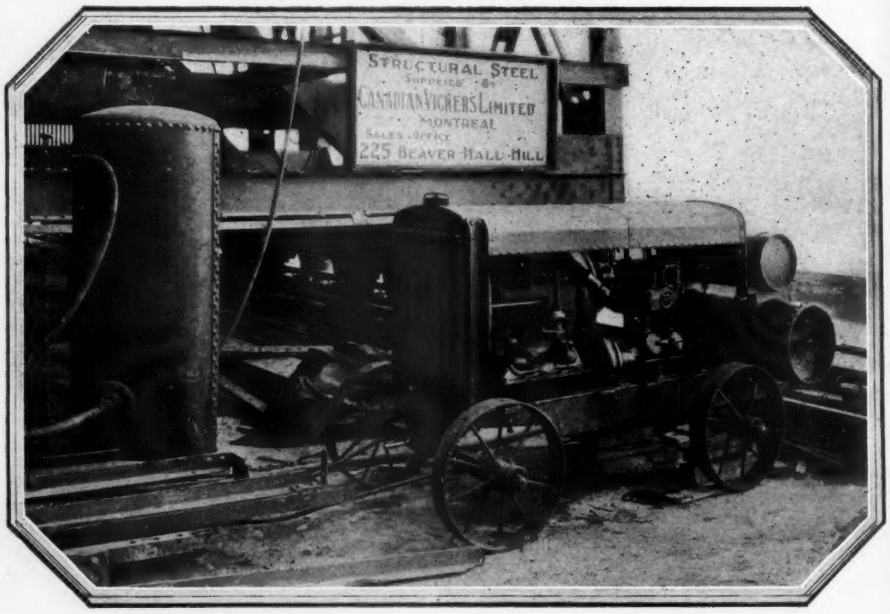
Several centuries have elapsed since the earlier explorers, homeward bound with rich cargoes of furs, sailed their tiny ships down the St. Lawrence and out across the Atlantic. Yet the new land was destined long to remain known to the outside world as the domain of *les bottes sauvages* and of the fur trader. At the opening of the present century Canada was still a distinctly minor factor in international business. There came, however, a period of exceptional development in agriculture, mining, lumbering, and industry in general. By 1921, based on the per capita value of her foreign commerce, the Dominion held a preëminent place among trading countries. Whether or not Canada maintains this position, she must henceforth be regarded as belonging to that group of nations which is both widely engaged and heavily dependent on international trade and, therefore, interested in shipping. While her rise is due to some extent to the enterprise of her people, still it is more directly attributable to the wealth of her natural resources.

In this respect the Dominion represents a contrast to other countries that manufacture, assemble, and distribute raw and partly-finished products received from every corner of

Airplane view of the Canadian Vickers plant in the harbor of Montreal.

the globe. This cycle of importing, manufacturing, and exporting is a relatively minor phase of Canada's foreign commerce. Her purchases abroad are for domestic consumption rather than for manufacture and resale, while her exports consist chiefly of surplus commodities produced from natural resources.

Within the past two decades Canada has become one of the biggest granaries in the world. According to an American observer, the greatest rush to take up farmlands in Canada occurred between 1902 and 1922, when the area sown in wheat was increased from 5,000,000 to more than 22,400,000 acres. The crop rose from 55,000,000 to 400,000,000 bushels, and the exports from 10,000,000 to 215,000,000 bushels. No other product within recent years has had so vital an influence upon the economic life of the Dominion as wheat. It may therefore be rightly called the "fairy godmother" to the industrial and the commercial life of Canada.



Portable air compressors have been found handy sources of power for the driving of pneumatic tools employed in erecting steel structures in the Port of Montreal.

The whole industry is sufficient to excite admiration not only because of its remarkable growth but by reason of the splendid organization needed to handle it. As soon as threshing commences, a veritable avalanche of grain begins to move from the farms of Manitoba, Saskatchewan, and Alberta. The volume of wheat to be marketed is tremendous; and the fields are far removed from the seaboards. The great problem is to ship as much of the crop as possible before grim winter closes navigation on the waterways leading to Montreal and to other Atlantic ports. Railways, banks, grain dealers, lake carriers, ocean-port authorities, elevators in the grain-growing districts both at the head and the foot of the Great Lakes and at the seaboards—all these and other vital interests join hands and work at top speed to receive, to clean, to grade, and to send forward continuously as large a flow of wheat as the various carrying and transshipping facilities can handle.

Air-operated wood borers and drift-bolt drivers save much time and labor in constructing caissons and crib work for underwater foundations.

To keep pace with the requirements of the grain trade, the number of elevators in the Dominion has increased from 523, in 1901, to 4,020 in 1922, with a total capacity of 18,000,000 bushels and 238,000,000 bushels, respectively. At present, Vancouver and Victoria are not equipped to handle such tremendous volumes of grain as Montreal and other Atlantic ports. Just how commanding Montreal's position is as a grain-exporting center is brought out by the following figures which cover a 7-month shipping period in the case of Montreal as against one of 12 months for the other cities:

	1921 Bushels	1922 Bushels	1923 Bushels
Montreal...	138,453,890	153,035,817	120,107,990
Galveston...	94,173,049	17,646,000	10,556,000
New York..	84,698,581	127,488,000	97,022,200
N. Orleans..	73,689,399	62,994,000	22,793,801
Baltimore...	55,314,808	88,521,000	42,454,000
Philadelphia	46,769,286	60,237,000	37,074,418

Hence, by far the greatest part of Canada's wheat crop goes to foreign markets by way of Montreal. A large amount of general cargo also comes down the St. Lawrence via the Great Lakes; and all this traffic has helped to make that port—although open to navigation only seven months in the year—the largest grain-exporting harbor in the world and the second largest seaport in North America—New York holding first place.

Montreal, which is 1,000 miles inland, is approached by a ship channel having a depth of 30 feet at mean low water and is connected with the very heart of North America by a canal-and-lake system more than 1,600 miles long. By means of this route, Duluth, Chicago, Detroit, Port Arthur, Fort William, and other important lake ports are linked with the Atlantic. Being closer to Europe than any other Atlantic seaport, Montreal offers unusual advantages as a shipping point not only to the Dominion but also to the American states bordering on the Great Lakes. Just

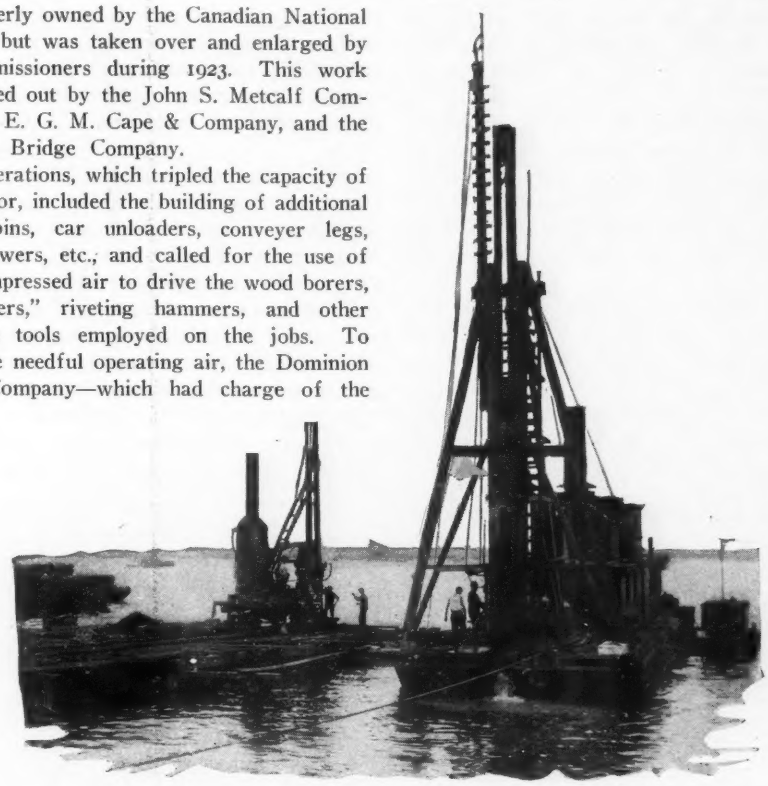
how much nearer it is to Liverpool, for example, is brought out by the following figures:

Montreal	2,773 miles
Boston	2,810 "
New York	3,010 "
Philadelphia	3,160 "
Baltimore	3,329 "
Panama Canal	4,530 "
New Orleans	4,553 "
Galveston	4,730 "

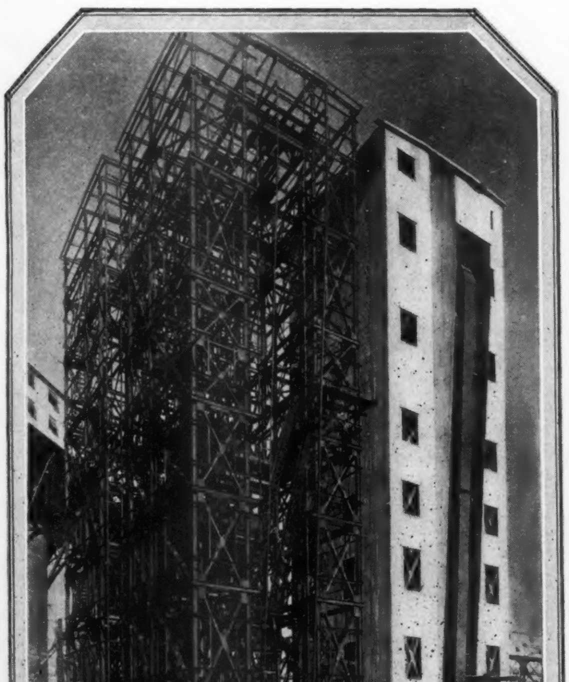
Every foot of the waterfront of the harbor, which extends for a distance of sixteen miles on each shore of the St. Lawrence, is public property and administered by the Board of Harbor Commissioners. Direct steamship service is maintained with practically every port in the world; and over Montreal's wharves pass annually almost one-third of the exports and imports of the entire Dominion, aggregating about $700,000,000. The capital invested in the harbor amounts to $39,000,000; and it is interesting to note that the bonds have never failed to pay interest.

The harbor now boasts 8½ miles of completed wharfage capable of accommodating 125 vessels; but the port facilities are steadily being augmented by the construction of additional docks. Four large public grain elevators are at present located there. These are known as Harbor Commission Elevators B, and Nos. 1, 2, and 3; and they have a combined storage capacity of over 12,000,000 bushels. Elevator B, located at Windmill Point, was formerly owned by the Canadian National Railways but was taken over and enlarged by the Commissioners during 1923. This work was carried out by the John S. Metcalf Company, the E. G. M. Cape & Company, and the Dominion Bridge Company.

The alterations, which tripled the capacity of the elevator, included the building of additional storage bins, car unloaders, conveyer legs, marine towers, etc., and called for the use of much compressed air to drive the wood borers, "Jackhamers," riveting hammers, and other pneumatic tools employed on the jobs. To supply the needful operating air, the Dominion Bridge Company—which had charge of the steelwork—drew on its fleet of Type Twenty portable compressors that it holds ready for just such undertakings.



Submarine drills, steam driven and of Ingersoll-Rand make, used in connection with important waterfront work.



Mobile towers, one of them in course of erection, designed for the unloading of grain from boats arriving at Montreal via the Great Lakes.

Elevator No. 1 is the largest seaport elevator in the world, having a storage capacity of 4,000,000 bushels. It is 530 feet long, 128 feet wide, and 202 feet high. Lake vessels and railway cars can discharge grain into its bins at the rate of 40,000 bushels and 36 carloads per hour, respectively. While this is going on, the elevator can also load grain abroad waiting vessels at the rate of 75,000 bushels an hour.

Most of the wheat received at Elevator No. 2—which has the distinction of being the first large terminal elevator to be constructed entirely of reinforced concrete—comes by rail. The dimensions of this structure are: length, 457 feet; width, 100 feet; and height, 200 feet. It has a storage capacity of 2,662,000 bushels, and is connected to Elevator No. 1 by means of a system of rubber belting, over 15 miles long, that can carry grain to all or any one of the 20 berths in the central part of the harbor at a maximum rate of 150,000 bushels per hour. This elevator is also provided with a vessel-loading conveyer gallery which does much to speed up the work during the rush season. The conveyer has four belts and can deliver grain simultaneously to two freighters at the rate of 35,000 bushels per hour each.

The newest and probably the most interesting of the immense grain-handling facilities at the Port of Montreal is Elevator No. 3, which is 640 feet long, 80 feet wide, and 200 feet high, and has a storage capacity of 2,000,000 bushels. However, the plant is so designed that its capacity can be increased to 14,000,000 bushels without adding to the mechanical equipment. This elevator has four modern car unloaders, capable of emptying 28 cars per hour; four marine legs that can handle 60,000 bushels per hour; and eight conveyers that permit four vessels to be loaded at the same time.

In laying out this plant every known facility for the prevention of dust explosions was made use of. Adequate dust-removal systems are also features of the other elevators in this port as well as of those elsewhere in Canada's grain-handling centers. Vacuum pumps and air compressors supply the operative power for these systems; and machinery of this kind is therefore an essential part of every up-to-date elevator.

Work on Elevator No. 3 was begun in 1923; and some 500,000 rivets were driven in erecting the 4,500 tons of structural steel required. It was also necessary to construct an extensive system of jetties and cribs to support parts of the buildings, towers, and galleries. As a modern grain elevator covers a good many acres it was expedient that a compressor plant be provided that could be moved from place to place without loss of time as the work progressed.

The Canadian Vickers Company, Ltd., which put up the structural steel, therefore decided to utilize one 7x6-inch and two 5x5-inch Type Twenty Ingersoll-Rand portable compressors. All these machines were at first employed, but

later on one of the smaller units sufficed for the work in hand. According to Mr. Malo, superintendent of erection, no trouble was experienced with these compressors nor did the 5x5-inch portable have any difficulty in supplying air for four 2-men riveting gangs after the other machines had been removed. An auxiliary receiver was used to prevent any drop in pressure that might result when four riveting hammers are run from a 5x5-inch compressor at one time.

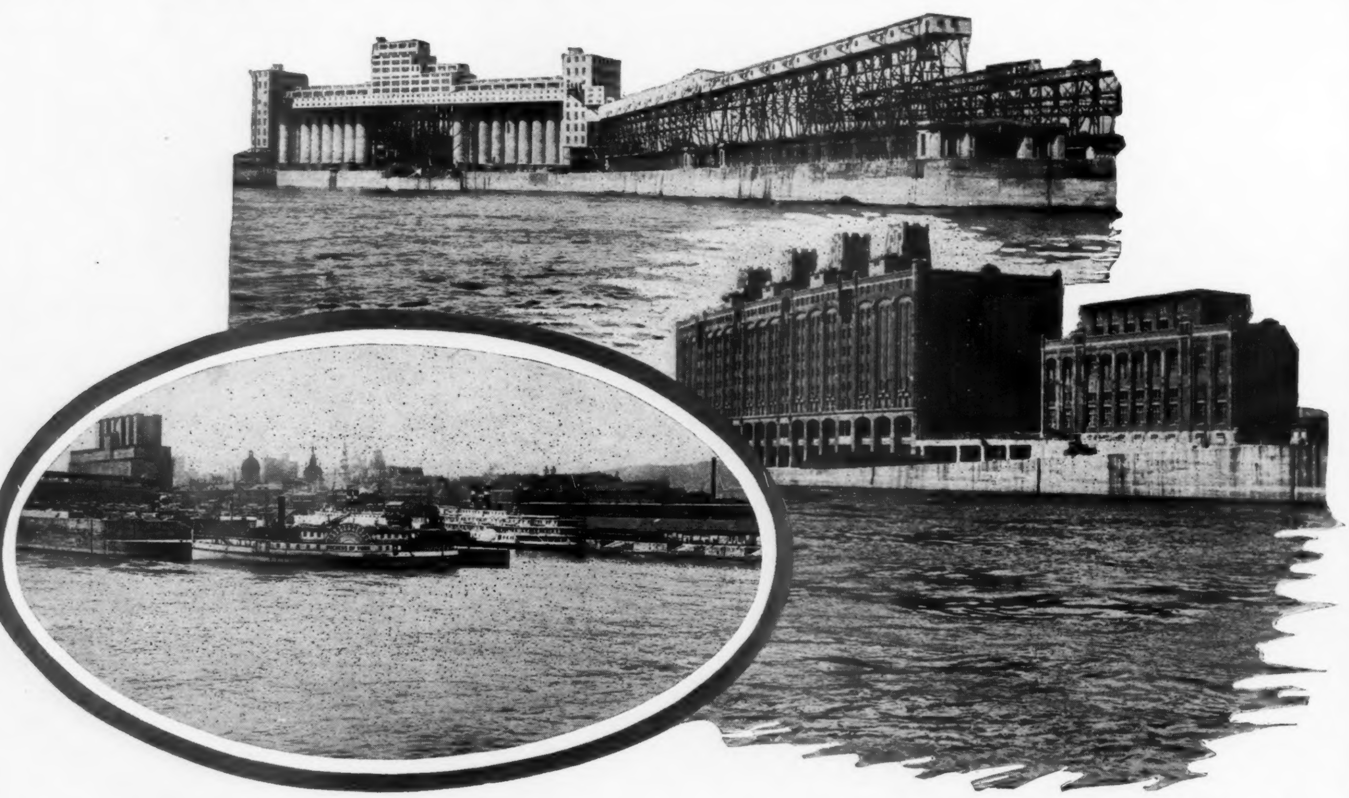
Another important feature in connection with this elevator was the erection of four traveling marine towers for unloading grain from lake boats. In building the jetty that supports the towers it was necessary to sink to a depth of 42 feet 9 inches a substructure varying in length from 286 feet 1 inch to 367 feet 1 inch, and having a width of 77 feet 3 inches. This foundation represents a total volume of 1,080,000 cubic feet, thus making it the largest ever constructed in Montreal, if not in the world. Operations were considerably hampered by late deliveries of timber; but by the aid of pneumatic equipment the job was finished during the first week of November, 1923. Before the close of navigation approximately a quarter of the concrete superstructure was in place. The timberwork on this jetty was done by the Atlas Construction Company, Ltd., of Montreal; but the dredging, rock filling, and sinking were carried out by the Harbor Commissioners. While Elevator No. 3 was built according to the designs and under the supervision of the John S. Metcalf Company, Ltd.—specialist in architecture of this kind—certain phases of the project, as previously mentioned, were handled by contractors familiar with the class of work involved. As usual in undertakings of this nature, compressed air was of great help in expediting the dredging, the erecting of the timber framework, and the rock filling. All the compressors used were of Ingersoll-Rand make.

The central section of the Port of Montreal is said to be one of the most intensively operated bits of waterfront in the world—having handled over 8,000,000 tons of freight in the 7½ months the harbor was open to navigation during 1923, or an average of about 35,600 tons per day. The high-level piers located there are 1,250 feet long, separated by slips 550 feet wide, and covered with 6 single-story and 20 two-story transit sheds. The latter are equipped with conveyer galleries so that grain can be received from Elevators Nos. 1 and 2 while general cargo is being loaded and unloaded. All the sheds are built of steel, and have roofs and floors of reinforced concrete.

For general construction and repair work about the harbor, such as is done by the Engineering Department of the Commission, a large amount of equipment has been provided and includes an 8x8-inch Type Fourteen portable compressor, numerous pneumatic tools, "Jackhamers," submarine drills, dredges, scows, etc. The portables, as can be readily appreciated, have proved very serviceable in supplying operating air to wood borers and drift-bolt drivers, employed on cribwork and for drilling holes in concrete piers for power-line poles, etc., and to paving breakers used in making pier alterations and for breaking up cobble stones. By the aid of this repair plant, the port authorities are able to perform numerous small tasks that would otherwise have to be turned over to outside contractors. On jobs of any magnitude, however, it has been found better to obtain competitive bids from firms specializing in the kind of work to be undertaken. One of these is now nearing completion and is dealt with here in order to show to what extent compressed air is relied upon in the upbuilding of this great port.

Expansion of shipping activities in recent years made the construction of additional piers and berths necessary. A contract was therefore let to Quinlan, Robertson & Janin, of Montreal, for twenty crib-work piers to be built in various sections of the harbor. Each of these cribs is 120 feet long, 45 feet wide, and 30 feet deep; is made of 12x12-inch fir timbers held together by 1-inch drift bolts from 30 to 42 inches long; and is assembled at some convenient point, towed into position, filled with rock, and sunk. Next it is backfilled and capped with a superstructure of concrete. Work on the project was started in the spring of 1924, and had to be rushed so that it would be well towards completion before the freeze-up in the fall. It was soon found that two men swinging 12-pound sledges could drive only one drift bolt in 48 seconds. Furthermore, as numerous holes had to be drilled in the timbers to receive the drift bolts, and as the necessary rock work was not progressing satisfactorily by hand methods, the contractors decided to use compressed air and, in July, purchased a 9x8-inch Type Twenty portable compressor, several wood borers and drift-bolt drivers, a "Jackhamer," and the necessary accessories.

A portable outfit was selected in preference



Courtesy, Board of Harbor Commissioners.

Various interesting aspects of the very busy Port of Montreal where enormous quantities of grain are transferred to ocean-going steamers.

to a stationary plant as it would obviate the building up and the tearing down of temporary housings and foundations; and to facilitate moving the compressor from one location to another it was mounted on a rented barge. This permitted bringing the machine right alongside the pier wherever air was required, thus avoiding long pipe lines and hose connections. The compressor in question supplied air enough to drive all the tools used at any one time as well as to operate the hoisting engine on the scow, when desired.

Holes for drift bolts could thereafter be drilled in a fraction of the time taken when ordinary hand-operated augers were employed for the purpose. It was also found that one man using a drift-bolt driver, furnished with air at from 80 to 90 pounds pressure per square inch, could drive a drift bolt in 17 seconds. In other words, one man with a pneumatic tool could do as much work in half the time as two men armed with sledge hammers.

Late in September it was decided to rent another scow and to put an additional compressor on the job so as to make certain of fulfilling contract requirements. A 7x6-inch Type Twenty portable machine, with the necessary tools, etc., was therefore ordered and promptly delivered by motor truck, as it was found that it would take 72 hours to ship the goods by freight. In this way, the compressor was actually on the job in less than 24 hours—thus saving the contractor over $1,000 for barge rent alone. It is doubtful if a similar record could have been made with any other type of compressor plant, owing to the time generally needed to put it in running order. Obviously, the modern portable compressor, apart from its other virtues, is also of great value in cases of emergency.

As can be readily appreciated, the industrial development of this harbor has gone hand in hand with the steady growth of its shipping facilities. Of late years, many large firms have established themselves there. Among these are: St. Lawrence Sugar Refineries, Canadian Spool Cotton Company, Canadian Vickers, Canadian Steel Foundries, Montreal Locomotive Works, Shell Oil Company, Canada Cement Company, and Imperial Oil, Ltd., as well as several flour and cereal mills. All these widely diversified industries employ compressed air to a very large extent.

A feature of the Canadian Vickers plant is the large floating drydock and shipbuilding and repair plant. The drydock is said to be capable of accommodating the largest vessel in the British Navy. Air for operating the many pneumatic tools used in this drydock and in the adjacent shops is furnished by a large Class PRB-2 Canadian Ingersoll-Rand compressor; and convenient hose connections alongside the dock make it possible to supply air at any desired point.

Another important adjunct to the port is the Harbor Commissioners' cold storage plant, which has a capacity of 4,628,000 cubic feet. This warehouse is up to date in every respect, and adjoins a dock where any ocean liner reaching Montreal may berth. An air-conditioning plant has been provided that reaches into each of the cold rooms; four water towers on the roof serve the automatic sprinkler system; and an Artesian well, 1,100 feet deep, furnishes water at a temperature of 42° F. in summer. This well is pumped by means of an air-lift. All important machinery in the power house, such as compressors, etc., are in duplicate so that the reserve equipment can carry the load in case of break-down. In the ice-making plant, operated in connection with cold storage, compressed air is employed for agitation.

In the two years the warehouse has been in service it has handled the following products:

	1922	1923
Apples	30,000 bbls.	43,970 bbls.
Butter	1,672,000 lbs.	2,957,864 lbs.
Cheese	13,250,000 lbs.	26,235,450 lbs.
Eggs	1,200,000 doz.	1,806,450 doz.
Frozen and pickled fish...	850,000 lbs.	1,222,229 lbs.
Meat	1,500,000 lbs.	4,633,065 lbs.
Poultry	500,000 lbs.	839,807 lbs.

In addition, large quantities of hops, ferns, nuts, figs, dates, dried apples, onions, celery, turnips, carrots, etc., were held there; and during the summer months of 1923 fur dealers took advantage of the facilities thus offered them. At one time that season upwards of $1,000,000 worth of valuable skins were in storage in that plant.

Much more might be written about this important and continually expanding inland seaport, but enough has already been mentioned to make Montreal's position in international commerce quite clear. In the preparation of this article, information was obtained from many sources; but special acknowledgment should be made of the aid rendered by the Harbor Commissioners, the Canadian Pacific Railway, and Canadian Vickers, who furnished essential data and photographs.

MINING IN RHODESIA

CONSIDERABLE activity is now evident in almost every branch of mining in Rhodesia. A group of capitalists, with which the Anglo-American Corporation of Johannesburg is closely associated, are developing the Bwana M'Kubwa, N'Kana, N'Changa, and other copper mines in northern Rhodesia; and at Bwana M'Kubwa a plant of 1,000 tons capacity per day is to be erected. Preston K. Horner, formerly general manager of the *Union Miniere* in the Belgian Congo, is in charge of operations, and Carl Davis, consulting engineer to the Anglo-American Corporation in which New York capital is interested, has recently made an inspection of the properties.

It is interesting to learn that the first steam shovels ever employed on mining work in British South Africa have recently arrived at the Bwana M'Kubwa property. These are of the well-known Bucyrus type. They will primarily be used on excavation work in connection with the new plant and then in open-pit mining operations in the big malachite deposit of the Bwana M'Kubwa mine.

MEASURING OF GAS TO BE STANDARDIZED

IN the field of natural gas, the measurement of fairly large volumes of gas, and especially those at high pressures, is of importance. It is not uncommon for a transmission company to buy gas from individual well owners and to pipe it to the limits of a town where another company retails it to the consumers. It is recognized as the best practice to have the transmission company measure both the gas it buys and the gas it sells. Failure to do this may result in considerable loss.

For example, the Peoples Gas Light and Coke Company of Chicago, Ill., buys many millions of cubic feet of gas per day. If one of the meters through which this gas is measured is in error by ½ per cent. and the price of gas, wholesale, is 50 cents per 1,000 cubic feet, the inaccuracy of the meter would represent a loss of $2.50 for every 1,000,000 cubic feet of gas. Where the meter passes 10,000,000 or more cubic feet per day, this loss would soon reach considerable proportions.

In order to arrive at some standard of measurement, the United States Bureau of Standards has been conducting some interesting experiments at Edgewood, Md., and at Chicago, Ill. This work, which is now nearing completion, was inspired by the rapid growth in the industrial uses of gas—the consumption varying from a few hundred to several million cubic feet per hour.

For the tests at Edgewood Arsenal, the Bureau obtained the use of four heavy compressors to supply the necessary air. A series of test lines were set up, with a short section of 3-foot pipe at the outer end. These lines were made up of 4-, 6-, and 8-inch piping. The discharge from the 3-foot pipe was through a flow nozzle, which formed the primary standard. The output of the compressors was rated at about 110,000 cubic feet of free air per hour at pressures up to 75 pounds per square inch and at about 75,000 cubic feet per hour at pressures between 75 and 250 pounds. While most of the tests were at pressures below 75 pounds, a few were made at the higher pressures. The ratio of orifice to pipe diameter ranged from 10 to 70 per cent. The differential pressure varied from a few inches of water to nearly 100 inches of mercury, or about 50 pounds per square inch. In connection with this work several different orifice shapes were tested.

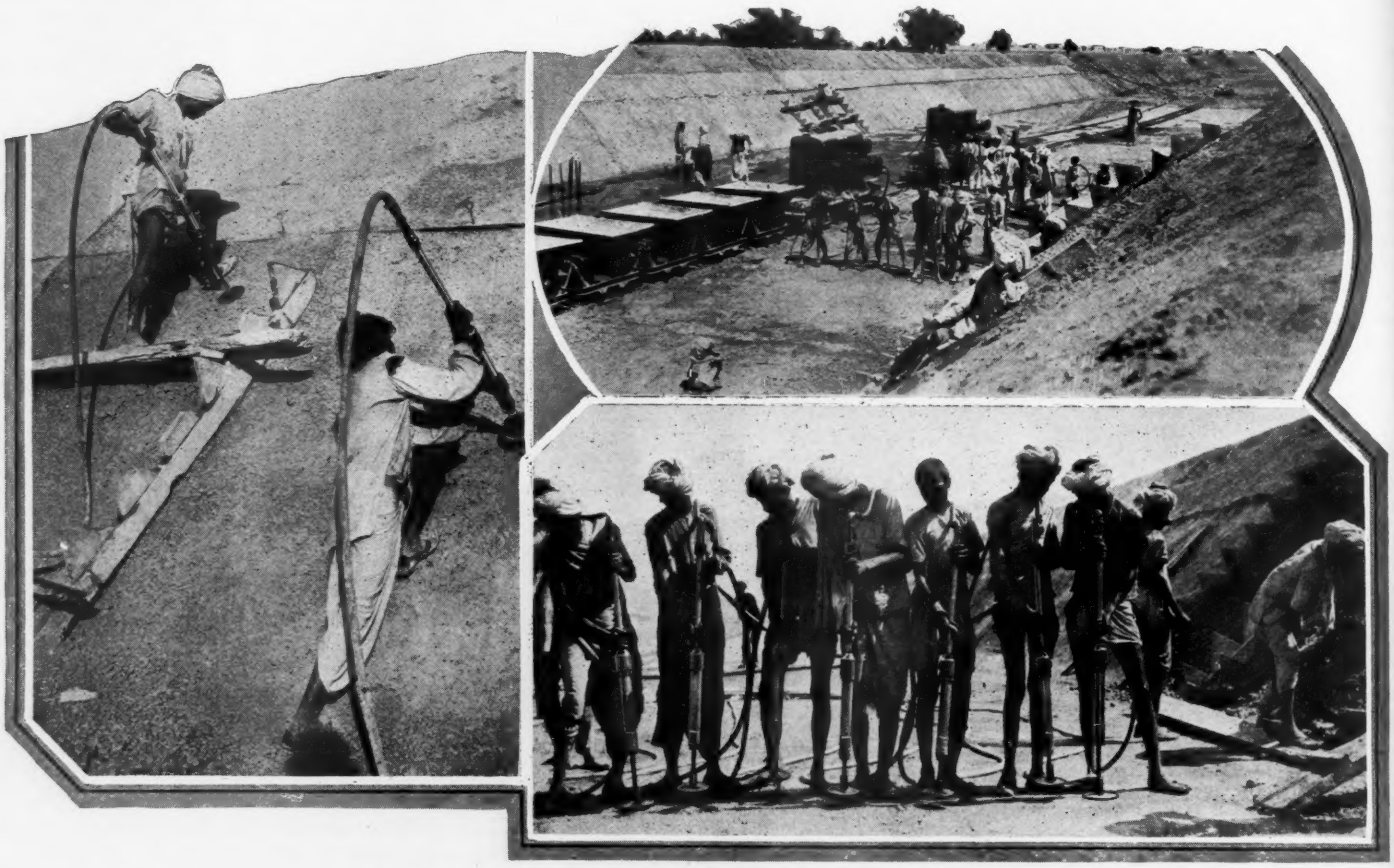
The investigations at Edgewood Arsenal were made by the Bureau, and concerned orifice meters only, while those at Chicago were conducted in coöperation with the American Gas Association and the Natural Gas Association—the experimental work being carried out in the plant of the Peoples Gas Light and Coke Company. The program of investigation at the latter place included, in addition to the orifice meters, a wet-drum station meter, a cycloidal-type meter, a Venturi tube, a Thomas electrical gas meter, and a large gas holder. These tests were made at low pressures, amounting to less than a pound per square inch, while those at Edgewood were made at high pressures, such as are sometimes used in natural gas mains.

AIR-DRIVEN TOOLS WIN FAVOR IN INDIA

FULLY two-thirds of India's teeming population of hundreds of millions of people are supported directly by agriculture and the subordinate industry of cattle raising. Normally, enough food is obtained from the soil to meet the needs of the inhabitants, but much sectional distress has been occasioned from time to time when droughts have reduced production and occasioned devastating famines. Therefore, to neutralize the effects of deficient rainfall, extensive irrigating projects have been taken in hand in latter years under the direction of the British Government; and the magnitude of this work is but little realized by the world at large. These diversified construction tasks have levied and still are levying heavily upon engineering skill and engineering equipment of many modern sorts.

One of the big irrigating undertakings calls for the construction of an extensive system of concrete-lined canals drawing water from the Sutlej River, at the foothills of the Himalayas, which has its source in the melting snows of those towering peaks. These canals are dug by drag-line excavators; and, because of the sandy character of the soil, these artificial waterways are lined with a 6-inch layer of concrete to conserve the water and to prevent it from saturating the adjacent land.

The practice is to mix the concrete at central plants and to move it in small dump cars to the points of application where it is spread and then tamped by air-driven sand rammers. Air for this purpose is supplied by numerous portable Ingersoll-Rand compressors of Types Fourteen and Twenty. The coolie laborer receives 12 annas a day, that is, about 25 cents. The entire job will take about three years to finish; and during that interval the savings in hand labor made possible by the adoption of air tools and other mechanical facilities will, so it is said, pay for the entire construction equipment.



Air-driven sand rammers making light work of tamping the concrete lining of miles of irrigating canals in the Punjab.

NEW WAY TO MAKE PAPER TEST SHEETS

APPARATUS designed to make uniform test sheets of fiber play an important part in the investigational work of paper laboratories, as such sheets—of uniform formation and weight—are required for making strength tests of pulp. Heretofore a hand mold has been used for this purpose, but latterly a sheet mold and a press have been devised that not only eliminate the personal equation—the chance of error—but make it possible to duplicate a certain kind of sheet as often as desired.

The sheet mold consists of a hollow base with an open top; of a wire-covered perforated plate which rests on the base; and of a deckle box, open at top and bottom, which is clamped on the perforated plate when a sheet is being made. An outlet pipe, leading from the underside of the base, is fitted with a quick-opening gate valve and a steam-ejector valve. When a test sheet is to be made the mold is filled with water over which prepared fiber stock is distributed evenly. The deckle box confines the contents to a definite area, thus limiting the size of the sheet. Next, the ejector valve and the quick-opening gate valve are opened; the water is quickly drawn down; and a sheet of fiber is formed on the wire mold. The sheet is then removed and placed in the press—a letter press—so fastened to platform scales that the pressure on the sheet is measured by the weight required to balance the lever arm of the scales. Comparisons made of the tensile strength, elongation, and tearing strength of a test sheet so produced show that the fibers are evenly distributed—in short, that a uniform product is obtained.

The barges now in service on the Mississippi River are capable of handling annually 1,000,000 tons of freight—the equivalent of 40,000 carloads.

FLYING ICEMEN

THE Spanish troops in Africa, in their campaign against the Moors, have suffered intensely from heat and lack of water, especially in the rough and mountainous country. One of the Spanish posts was located on top of a hill protected by blockhouses and barbed wire, and below were trenches and shelters in which the Moors awaited the sortie that they expected their enemy to make to get water. But they were doomed to disappointment because aircraft were called upon to relieve the situation. The flying machines did this effectually, and daily delivered supplies of ice and water.

Roadbuilding in the Foothills of the Adirondacks

By S. G. ROBERTS

Left—Hauling stone from the quarry to the crusher. Right—Road to Ticonderoga torn up preparatory to reconstruction.

TICONDEROGA is a name to conjure with because of the historical associations that form the background of this attractive and busy township in Essex County, New York. One has only to turn over the pages recording the evolution of the United States to learn that Ticonderoga has played a varied part in the days when the French and the English battled for supremacy and, later, when the rebelling colonists took up arms against the rule of King George III.

Ticonderoga stands where the clear waters of beautiful Lake George flow into neighboring Lake Champlain. These two lakes for many decades constituted the route by which Indians, trappers, pioneers, and contending military forces traveled north and south between Canada and what we are now pleased to call America. And, as might be expected, Ticonderoga early became a strategic point which warranted the erection of permanent defenses.

It was there that the French reared fortifications in 1755—naming the place Carillon; and there Montcalm established a rendezvous for his army two years later. In 1758, Abercrombie, the notoriously incompetent British general, attacked the position and was repulsed with a loss of nearly 2,000 while the French suffered a loss of less than 300. After this repulse, Abercrombie retreated precipitously; and the French held undisputed sway until the British, under General Amherst, invested Ticonderoga on July 22, 1759. During the night of the 23rd, the French commander, Bourlamaque, retired from the fort taking with him the best of his troops, but leaving behind him a sufficient garrison to maintain a brisk and a deceptive fire whenever the fort was approached by the enemy. Amid the darkness of the night of the 26th of July, the garrison also abandoned the position—firing the magazine by means of a train. The explosion blew up much of the fort and left little more than ruins for the surprised Britishers to take over.

Fort Ticonderoga acquired strategic importance at the very beginning of the Revolutionary War. Early in the morning of May 10, 1775, a force under Ethan Allen arrived on the shore of Lake Champlain. Not finding enough boats to ferry all his forces from the eastern side of the lake across to Ticonderoga he made a surprise attack with only 83 men, and so effective was this move that the British surrendered without striking a blow. By this maneuver the colonists gained possession of the key to the route to and from Canada and captured a number of cannon and a considerable quantity of powder and ball, which they much needed. On July 1, 1777, Burgoyne, in his march south, appeared before Ticonderoga. The British seized a position which commanded the fort and thus compelled the garrison, 3,000 in number,

Top—A bit of the main street of the town of Ticonderoga. Left—Along the shore of beautiful Lake George. Right—An architectural landmark on the road between Hague and Ticonderoga.

Looking east from one of the parapets of Fort Ticonderoga which once dominated the route to and from Canada on Lake Champlain and figured conspicuously during the period of the French and Indian War.

to evacuate. The effective colonial troops retired into the Green Mountains to the eastward, while the women and children and the wounded were sent to Fort Edward near the southern end of Lake George.

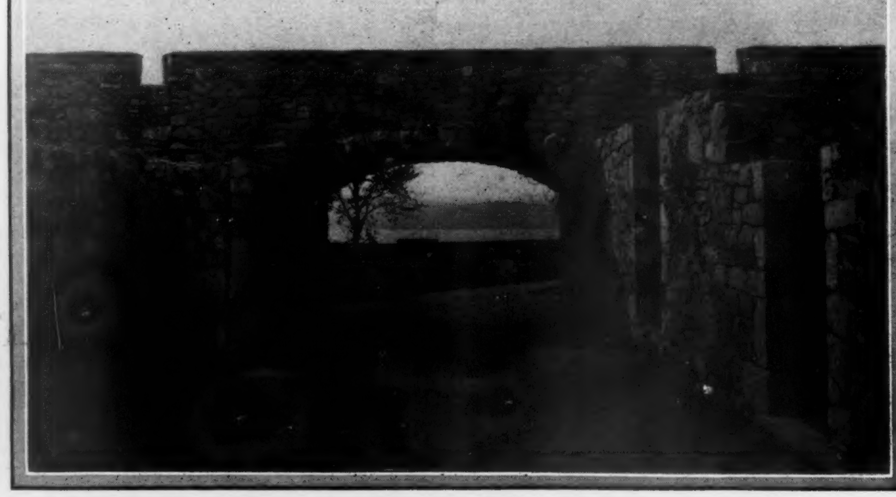
These historical high points are mentioned because Ticonderoga is annually visited by thousands of tourists traveling either to and from Lake George or journeying into or out of the Adirondacks. This motor traffic has been somewhat handicapped in the years gone by the nature of the public highway linking Hague-on-Lake George with Ticonderoga. Latterly, steps have been taken to correct this drawback to easy and comfortable travel, and there is now nearing completion a broad and thoroughly modern road covering a stretch of a little more than eight miles. Long before the summer of 1925 is ended this thoroughfare will be finished and in active use.

The present contractors, the firm of Armstrong & Trowbridge of Middletown, N. Y., started work upon the undertaking in the early part of last August; and from then on, until weather called a halt on further activities in the latter part of November, they pushed the work ahead with all practicable dispatch. The road, which is 28 feet wide between shoulders and has a 16-foot pavement, is of a rock-ballasted type with a top binder of asphalt. All told, the road will necessitate the placing of substantially 12,000 cubic yards of stone calling for the quarrying of fully 15,000 cubic yards of rock. Fortunately, rock of a suitable character is obtainable from an outcropping ledge right alongside the highway and approximately midway between Hague and Ticonderoga. This rock is like most of the rock forming the substructure of the Adirondacks, in the foothills of which Lake George lies.

One of the most troublesome problems for the roadbuilder in the Adirondack region has been that of getting his rock at a reasonable cost and at a point near the scene of his operations. There was a time when rock for this purpose could be quarried by hand at a cost which made that procedure feasible, but this happy state of affairs no longer exists. It is now necessary to have recourse to labor-saving equipment wherever this can be done, and to this end the contractor must make use of mechanical facilities which have been devised in recent years. In order to furnish operating air for the "Jackhamers," which do the drilling at the quarry in question, Armstrong & Trowbridge utilize an Ingersoll-Rand 8x8-inch Type Fourteen portable compressor. This machine, which is capable of providing the equivalent of 210 cubic feet of free air per minute at a pressure of 100 pounds, is partly protected from the weather by an open structure supporting a roof. The portable also supplies the compressed air required to work a "Leyner" drill sharpener that is set up in a near-by blacksmith shop. The rock in the quarry is of granite formation and hard. The blacksmith on the job freely declared that he would be unable to keep all the drills in proper condition if he had to do the work by hand.

Adjacent to the quarry the contractors have established a rock-crushing plant capable of handling 25 truck loads of rock daily; and this crusher turns out stone in the various sizes needed for the building of the road. To be specific, the first 9 inches forming the foundation or sub-base is composed of fairly good-sized pieces of rock which are arranged by hand. Next follows a 3-inch course or layer of crushed stone which is compacted by steam rollers. Then there is spread and rolled a third course consisting of $2\frac{1}{2}$ inches of fine or granulated stone—making all told a rocky base having a depth of $14\frac{1}{2}$ inches.

A final topping of hot asphalt is forced into the stone under pressure by means of a distributor mounted on a motor truck, commonly known among the workmen as the "tar baby." At the loading point, in Ticonderoga, the asphalt is heated by steam until it is of the desired degree of fluidity; and the stuff remains hot enough in the tank to flow properly when carried to the far end of the road. The spreading of the asphalt is effected by a 4-inch rotary pump driven from the truck transmission. This pump delivers the fluid, under pressure, to a horizontal distributing "bar"—really a pipe—having slits spaced six inches apart through which the asphalt can be squirted vigorously downward into the porous mass of stone. The asphalt serves the double purpose of binding the underlying rock and of forming a smooth running surface for vehicular traffic.



Through this gateway on May 10, 1775, Ethan Allen and a handful of soldiers captured Fort Ticonderoga from the British without a blow.

The road between Hague and Ticonderoga has been undergoing improvement for more than two years—another contractor having essayed the task before it was attacked by Armstrong & Trowbridge. The job has not been an easy one. In addition to troublesome physical conditions that have called for extensive excavating and backfilling, the winters are usually rigorous in that section of New

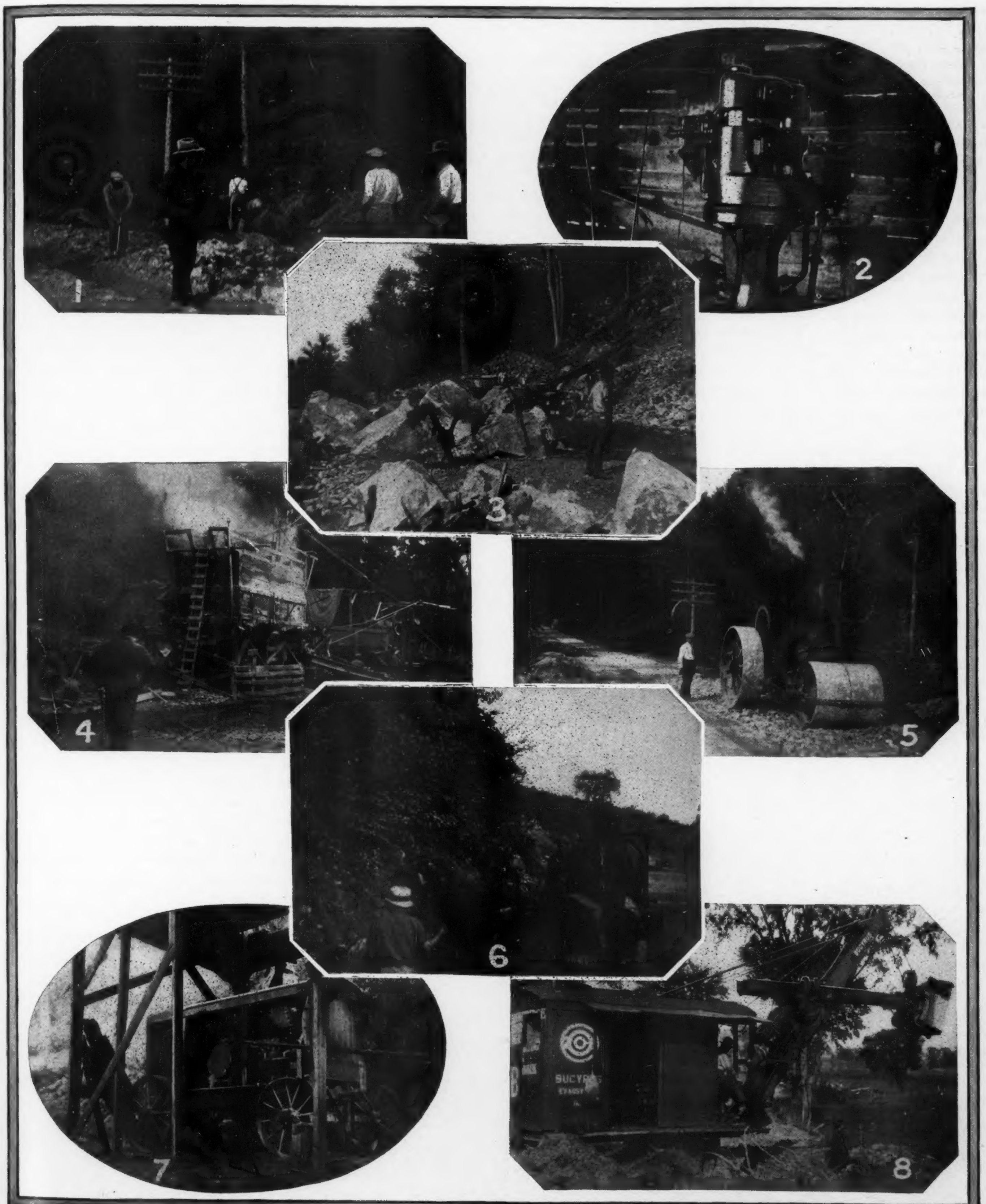


Fig. 1—Laying the rocky sub-base of the new road.
Fig. 2—"Leyner" drill sharpener in the blacksmith shop on the job.
Fig. 3—Near-by quarry which provides the rock for the road.
Fig. 4—Stone-crushing plant at the quarry.
Fig. 5—One of the steam rollers in action.
Fig. 6—Asphalt distributor familiarly known to the workers as the "tar baby."
Fig. 7—Ingersoll-Rand portable compressor which has furnished all the motive air for the quarry and the blacksmith shop.
Fig. 8—This steam shovel has made light of the work of gnawing into neighboring banks while widening the roadway.

York State, and the heaving action of frost is apt to be damaging to any road that is not well drained. This explains why it was finally found necessary to provide a considerably deeper rocky base than is needful in regions where the frost does not penetrate so far into the ground.

The contract price for the road now under construction is $157,000; and it is estimated that this splendid new highway will be turned over to the state during June of the current year. It will prove a boon not only to touring motorists but to thousands of people living adjacent to Lake George and Ticonderoga or who spend a portion of every summer thereabouts. Lake George has been made famous by James Fenimore Cooper, and the scene of one of his most successful books, *The last of the Mohicans,* is laid there. Long before the white man arrived, the aboriginal red men frequented the lake; and so much were they impressed with the charms of that lovely body of water, surrounded by mountains, that they spoke of it variously as "The Silver Bowl" and "The Smile of the Great Spirit."

DRIVING STEAM LOCOMOTIVE WITH COMPRESSED AIR

HOW he moved a locomotive from the repair shop to the roundhouse by compressed air instead of steam is an exploit about which A. H. Tucker still likes to talk. Mr. Tucker is now an engineer on one of the fast trains of the Burlington Railroad; but when he did the trick that so delighted him he was serving as an "engine tamer" in one of the company's shops.

In those days, when a locomotive was ready to be run from the shops to the roundhouse only several hundred feet away, it was the practice to fire up and to raise steam in the locomotive boiler so that she could be moved out under her own power. The shop superintendent and others always growled at this procedure because the smoke and the dirt were very objectionable. Such, however, was the way the shift was usually effected.

Younk Tucker, being rather fertile minded, proposed to make an experiment, and he informed his boss that the next engine would be driven out of the shop by compressed air. When the time arrived, Tucker proceeded to charge the locomotive's cold boiler with air from the regular shop line which carried air at a pressure of 100 pounds. The "super" stood by interested but skeptical; but when the searching air revealed leaks at several points he entered into the spirit of the undertaking and ordered the fitting of gaskets to properly seal the troublesome pipe connections. Then, with everything tight and the gage standing at 100 pounds, Tucker climbed into the cab and took his place on the driver's seat. What followed, he describes in this way:

"As soon as I opened the throttle a little bit the locomotive fairly jumped, and in a few seconds we were jogging along merrily—compressed air, you know, acts a good deal quicker than steam. I was nearly as much surprised as the old man, but I kept my head and carried that engine into the roundhouse without a hitch. It was a fine performance, and more than once afterwards I resorted to that method before we had available a small yard engine for shifting purposes. Even so, compressed air was a cleaner means of getting a dead locomotive in or out of the shop."

We are all to remember that Christiania, the capital of Norway, is henceforth to be known as Oslo—the name the city bore before the Danish invasion, several hundred years ago, when King Christian IV. bestowed his own name upon it.

© Military Engineer.
Chinese coolies engaged in tamping earth.

HOW EARTH IS TAMPED WHERE LABOR IS CHEAP

EIGHT men to handle one tamper? Impossible, you will say, one man is all that is needed to operate a pneumatic tool of that description. To those of us accustomed to having things done in the occidental way, it does not seem possible that other less progressive peoples still go about much of their work in a very primitive fashion.

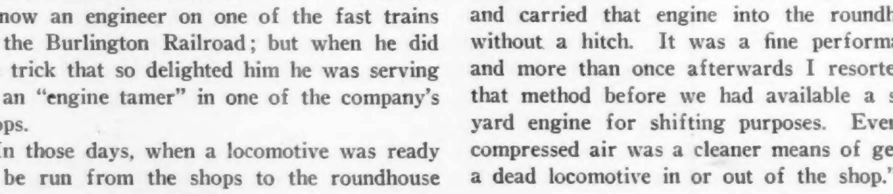
The problem of flood control in China is a very serious one; and a great deal of the labor in connection therewith is still being done by hand methods. In building four miles of new dikes on the Yellow River, all the earth was carried in baskets slung on poles or wheeled in barrows an average distance of 200 feet. Then it was packed in 1-foot layers by what are known as "flappers"—limestones weighing about 125 pounds apiece—each of which requires a gang of from seven to eight men to handle. In this manner substantially 3,500,000 cubic yards of dirt was transported and tamped.

We are not told how long it took to complete the job; but it is safe to say that one man with an air-driven tamper could easily have done as much if not more work in a day than the eight Chinamen with their flapper.

ANTI-FREEZE MIXTURES

ALCOHOL, in the opinion of the Bureau of Standards, still holds the lead as the best material to keep automobile radiators from freezing in cold weather. However, if wood alcohol is employed for this purpose, care must be taken that it does not contain acid which is likely to corrode the radiator or other parts of the circulatory system.

The drawback to the use of alcohol is that it evaporates from the solution and therefore has to be replaced. This is not the case with glycerine, but glycerine, on the other hand, is more expensive. It will probably interest automobile owners to know that tests have been made by the Bureau of Standards with a number of different anti-freeze preparations. The conclusions drawn, together with the opinions of members of the Automotive Section, are embodied in Letter Circular 28, copies of which may be had on application to the Bureau of Standards, Washington, D. C.



A portable type of rivet forge has been adopted by the California Transit Company to facilitate the heating of rivets wherever that work is necessary throughout the plant. The torch makes use of a combination of gas and compressed air to furnish the essential heating flame; and a simple clamp is employed to hold the torch at any desired angle in order to direct the flame into easily assembled firebrick furnaces.

Big Portland Cement Plants in Birmingham

Because of Its Available Raw Materials This Alabama City is Fast Becoming an Important Center for the Manufacture of Cement

By VERNON H. VANDIVER

COUNTLESS ages ago, prehistoric man, in an effort to secure himself against nocturnal visitors, rolled a huge stone into the entrance of his cave. This precaution, however, if obscure hieroglyphics may serve as a basis for the statement, did not prevent unfriendly snakes and other small animals causing him no end of worry. By accident he discovered that a certain kind of mud would harden in the sun and thus form a sort of stone; so he built himself a house of dried mud cakes to keep out unwelcome guests.

Succeeding generations improved upon this idea; and years later building blocks were hewn out of stone and held together with a kind of mortar. But, as man became more and more enlightened he sought to make the house in which he lived a permanent structure—one in which the mortar should have the same wearing quality as the natural stone.

Early in the nineteenth century it had become the custom to make mortar by burning lime rock—thus completing the transformation of its carbonate of lime content into oxide of lime. But no matter how carefully the rock was ground before pouring it into the crude kilns, the resulting material always contained a great amount of undesirable slag or clinker.

About this time, in 1811, there lived in Leeds, England, one Joseph Aspdin, a mason, who had long cherished the idea of producing a better binder for the bricks he laid. The thought came to him that the despised clinker might possibly be worth something. He experimented—ground some of it into a fine powder and mixed it with water. On being allowed to set, the mass became harder and harder, growing the while more and more like stone. At length, even the famed building stone from the Isle of Portland—Portland stone—which the cement resembled in color, was no stronger nor more solid. Because of this fact, Aspdin, in announcing his discovery, stated "this new material shall be known as Portland cement."

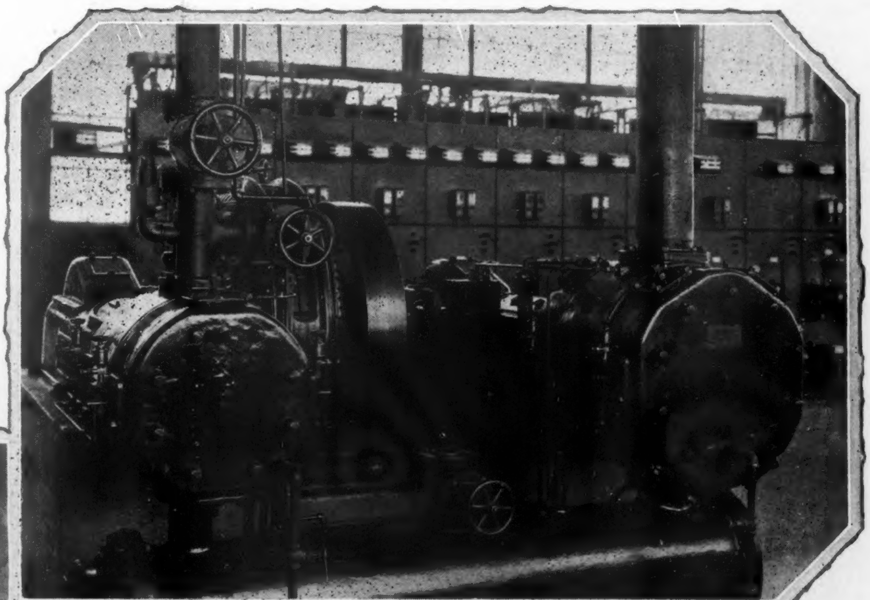
During the year just passed, the Portland Cement Association, a national organization for the promotion of the uses of concrete, published a book commemorating the 100th birthday of Portland cement. And, before going on with our story, it might not be out of place here to tell how it happens that the bulk of the world's supply of Portland cement is now manufactured in the United States.

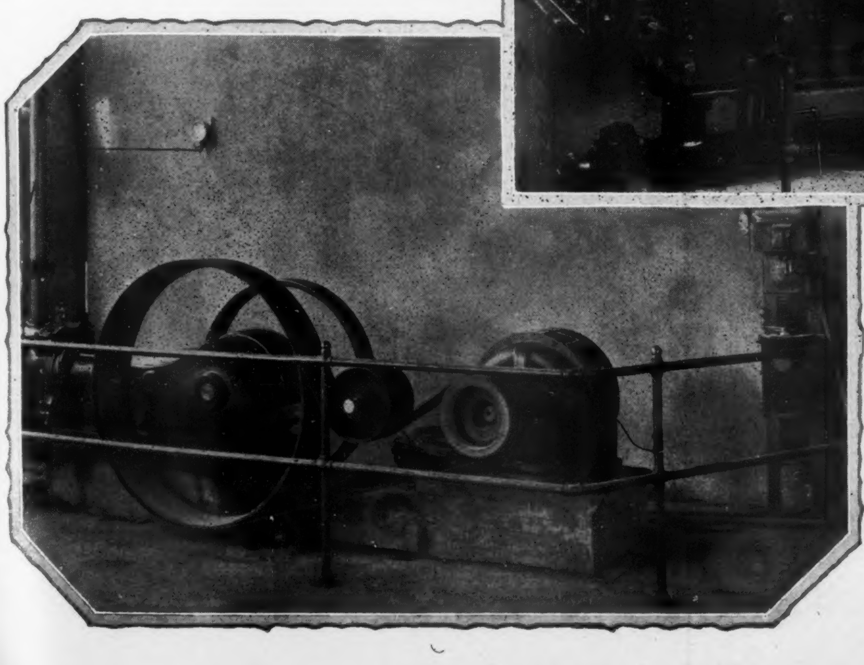
Following Aspdin's discovery, there came a long period of development in which the science of the chemist displaced guesswork in cement making. At length, interest was aroused in making this product here. After much experimenting with crude apparatus, and after many disappointments, good Portland cement was finally made; and in 1872 the first American plants were established in Pennslvania and in Indiana.

Then followed a period when imported and domestic Portland cements competed for favor in this country. Those in charge of important building projects had come to rely upon foreign cements and at first regarded the American product with suspicion. But the domestic manufacturers, by dint of close attention to the quality and reliability of their cement, succeeded in establishing a reputation for it that eventually won for them the United States market.

Since the establishment of the pioneer Portland cement plants in the United States in 1872, this industry has grown by leaps and bounds. Contrast the production of only 82,000 barrels, approximately 16,400 tons, during the seven years from 1872 to 1879 and 8,500,000 barrels in 1900 with the enormous production during 1924 of about 148,000,000 barrels, or 29,600,000 tons.

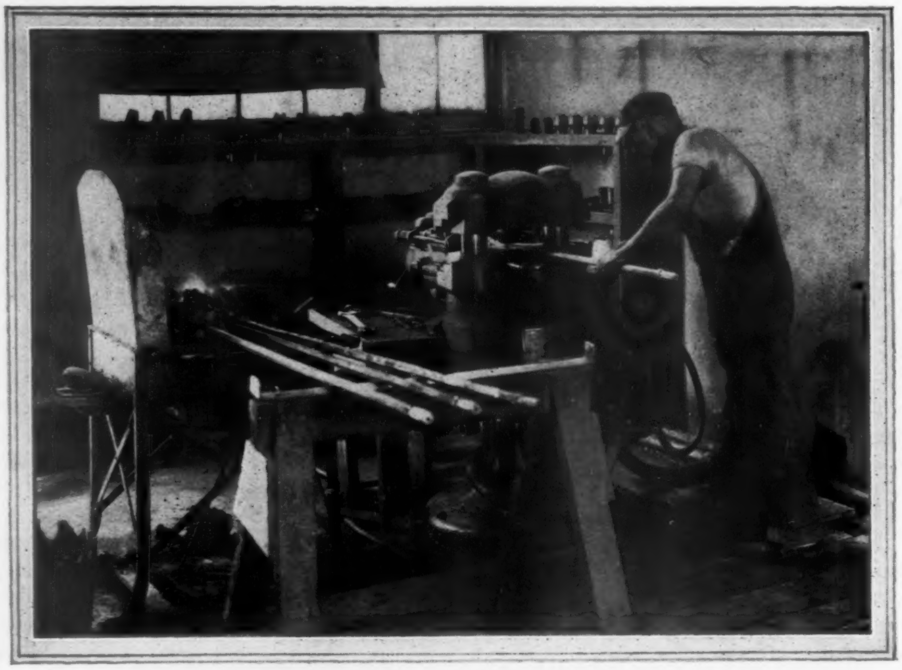
According to the *History of the Portland Cement Industry in the United States,* "the composition of Portland cement is, in general, about 20 per cent. silica; 10 per cent. alumina,





These Ingersoll-Rand compressors were installed by the Phoenix Portland Cement Company to furnish operating air for rock drills, a drill-steel sharpener, and other pneumatic equipment with which the quarry and the mill are provided.

plus ferric oxide; 65 per cent. lime; and 5 per cent. other compounds. The required combination of these materials may be obtained by mixing limestone, chalks, or marl with clay or shale or other argillaceous materials, or by taking a cement rock in which all ingredients are present in nearly the proper proportions, then adding limestone or argillaceous material as may be required to produce the proper balance of these ingredients. During burning, the



The blacksmith shop of the Phoenix Portland Cement Company is equipped with a "Leyner" sharpener to take care of the drill steels needed to quarry 1,000 tons of rock a day.

combination of the lime and silica, alumina, and iron oxide taxes place. The product resulting from proper burning is called clinker. This consists of silicates, aluminates, and ferrites of lime in certain definite proportions. The Portland cement of commerce is the product resulting from grinding this clinker to a fine powder."

It is fitting and proper that Birmingham, Ala., should share in the development of so great an industry. Birmingham owes her existence as an industrial city to her vast mineral resources. It was said that the giant iron man, which the Birmingham district exhibited at the World's Fair, Chicago, could stand with one foot upon an imposing mountain of iron ore and with the other upon a mountain of coal and that the valley between was rich in limestone. This is, of course, a little far-fetched, but within the city limits there are big deposits of iron ore, coal, and limestone—the latter accounting for the two great new Portland cement mills located there. These plants are within two miles of each other, and each has a capacity of 1,500,000 barrels a year. Both plants were built at about the same time, but one employs the dry process and the other the wet process.

Birmingham, with her abundant supply of limestone, shale, fuel, power, and labor, offered the Phoenix Portland Cement Company and the Lehigh Portland Cement Company many advantages. At the same time her excellent shipping facilities made that city an ideal distributing point for their product. On September 25, 1922, the Phoenix Portland Cement Company broke ground at Birmingham for the erection of its No. 2 plant, and on June 1, 1923, cement was loaded into box cars and shipped from there. Only eight months and six days to build a cement manufacturing plant having a capacity of 1,500,000 barrels a year. This, according to *Rock Products,* constitutes a record —it being the first plant, to its knowledge, ever to be built in less than ten months.

The raw materials owned by the Phoenix Company, according to Mr. Lindley C. Morton, its president, are of uniform quality and contain but little moisture. This enables the company to utilize the dry process, and to make cement that will pass the present rigid specifications at a saving in fuel over other methods of about 31 pounds of coal per barrel. The Lehigh Portland Cement Company's plant, its sixteenth, produced clinker on August 6, 1923, just eight months and seventeen days after the ground was broken. This plant also has a capacity of 1,500,000 barrels a year; but it employs the wet process.

In order to produce 3,000,000 barrels of cement annually, it is necessary to supply approximately 2,000 tons of stone to the crushing plants each working day. This means that the quarries, operated by the companies, must have a daily output of 1,000 tons each. As these workings are much alike, it will serve our present purpose to describe but one of them here—that of the Phoenix Portland Cement Company.

The property being flat, pit operation is practiced. In opening up the working but little overburden had to be removed: but the first eight or ten and in some places twenty feet of stone represented a difficult drilling problem. The stone pitched at an angle of about 45 degrees from the horizontal and was seamed with loam varying in thickness from two inches to a foot. At first, an attempt was made to drill with piston drills. This proved well-nigh impossible: more holes were thus lost on account of stuck steels than were completed.

Just about that time the Ingersoll-Rand Company had begun to market a new "Leyner" ham-

Left—A battery of "Leyner-Ingersoll" X70 drills made short work of the drilling for the opening blast. Right—It is not an uncomm performance for the X70 to drill as much as 200 feet of hole a day in hard rock.

mer drill, known as Type X70. The Phoenix Company decided to try this new drill, and, accordingly, had one put to work alongside a piston drill. On the strength of the showing made during that test several more X70's were put on the job; and a "Leyner" sharpener was also installed to keep the drill bits sharp and the shanks in perfect condition—two things vitally important to the successful operation of any hammer drill. Air power for this work was at first furnished by a 12x10-inch Class "ER1" compressor. With the addition of the new drills and the sharpening machine the air supply was augmented by the installation of a 12-inch-stroke Type "XRE" compressor.

A considerable number of holes was drilled before a single blast was made—it being the purpose to keep the drilling well in advance of actual requirements. When blasting was finally commenced, "Jackhamers" were utilized for popholing or for breaking up the large boulders preparatory to loading them by electrically operated shovels into waiting dump cars.

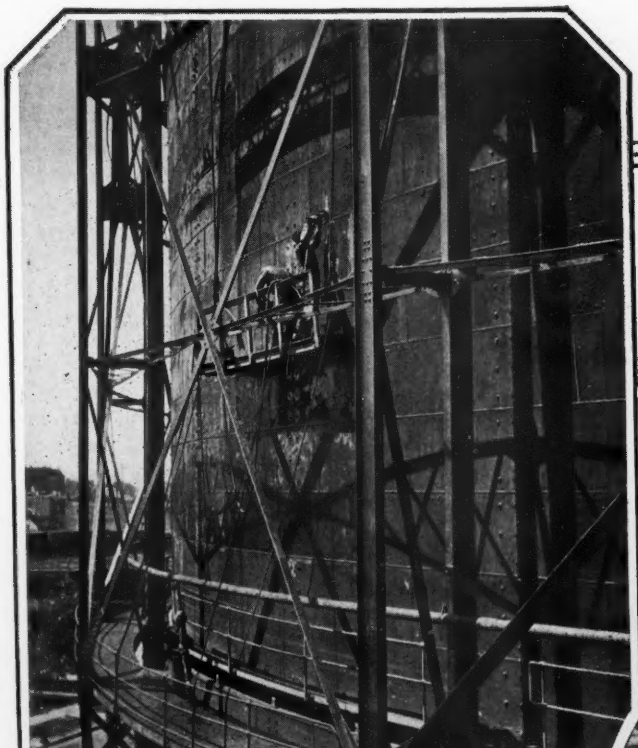
The loaded cars are then pulled, by an 8-ton General Electric storage-battery locomotive and a 15-ton Davenport steam locomotive to the foot of an incline leading from one end of the quarry to the crushing plant. Each locomotive hauls from four to six cars, while the incline handles but one car at a time by the aid of a single-drum hoist actuated by a 100-H.P. motor.

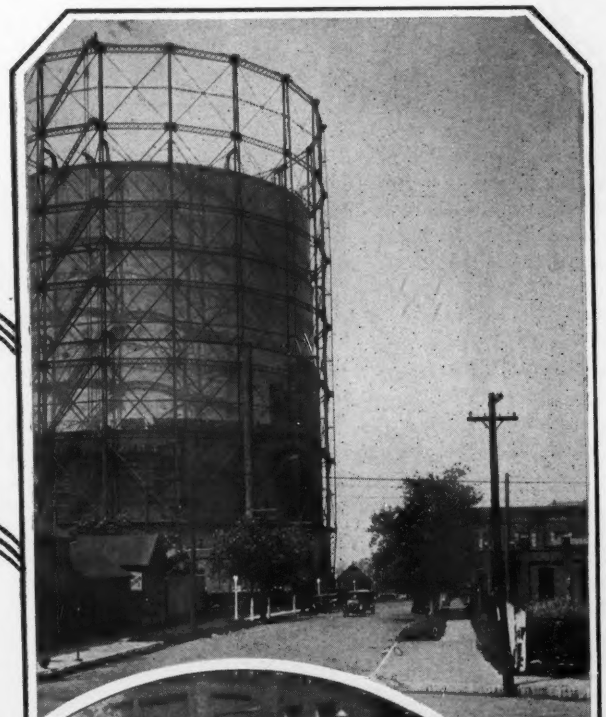
Until the quarry is lengthened to approximately 1,500 feet and widened to from 150 to 200 feet it will be operated to a depth of only 20 or 22 feet. Later, the floor will gradually be lowered, working 15 feet at a time. The deposit has been analyzed and found to be suitable to a depth of 200 feet.

AIR-DRIVEN WIRE BRUSHES CLEAN GAS HOLDER

THE Peoples Gas Light & Coke Company of Chicago, Ill., was recently confronted with the problem of how best to clean the outer surface of one of its holders, capable of taking care of 5,000,000 cubic feet of gas. For reasons which need not be considered now, the holder had not been painted for more than two years, and had reached a condition calling for prompt and radical attention. The two bottom lifts of the tank were in an especially bad way owing to the fact that they had been lowered twice every day into the water seal and then raised again. Due to the action of the water and the air, the paint was blistered and loose and much of the metal was covered with a thick coat of rust. The three upper lifts were not so much in need of attention and could be made ready for repainting with comparatively little work. The cleaning of these lifts was done by hand.

The two bottom lifts were cleaned with air-operated wire brushes, and the air for this purpose was furnished by a portable air compressor. The wire brushes did their work well; and the foreman in charge has declared that it would not have been possible to do this work satisfactorily by hand. This is not hard to grasp, because the plates of the holder are very closely riveted and the metal between the rivets was deeply corroded. The high speed of these No. 601 pneumatic wire brushes enabled them to get in between the rivets and to clear away the rust and scale preparatory to painting. Furthermore, the mechanical brushes were the means of saving a great deal of time and of lightening the labor of the men that used them.





Left—Cleaning the outside of a large gas holder with air-driven wire brushes.
Right—The big 5,000,000-cubic-foot holder that had to be cleaned.
Bottom—Air for the operating of the wire brushes was furnished by a 5x5-inch, Type Twenty portable compressor.

Norway's merchant marine has been restored to its pre-war strength and now stands eighth in the list of maritime powers. This is a fine showing in view of the fact that that country lost about 50 per cent. or 1,700,000 gross tons of her shipping during the World War.

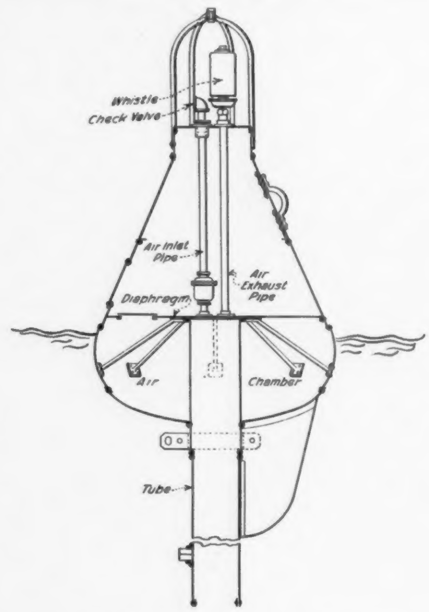
HOW THE WHISTLING BUOY WORKS

By SIDNEY MORNINGTON

THE whistling buoy is a navigational paradox: it is seemingly merriest when the tempest is at its worst. The voice of the whistling buoy ranges all the way from a modest moan to a high-pitched shriek; and there are times when the thing sounds like the last expression of misery. And this reminds us of a story.

Years ago, one of the dignitaries of the United States Lighthouse Service married for the second time, and by way of a honeymoon he took his mature bride upon a tour of inspection of the lighthouses on the Atlantic coast. The lady was not a good sailor; and the small tender in which the trip was made rolled often and deeply with the least encouragement. The bride was decidedly seasick and her moanings frequent and dismal. The bridegroom, with an eye to local color, tried to comfort the sufferer by calling her his "dear little whistling buoy." His simile was not flattering although reasonably exact.

For the sake of those unfamiliar with navigational aids, let us say that it is the purpose of the Lighhouse Service to place buoys wherever it is necessary to guide the mariner away from hidden dangers and to direct him by the surest and the shortest routes to suitable havens. Therefore, in order to make these markers both distinctive and serviceable when the weather is thick, it is customary to anchor either bell buoys or whistling buoys wherever the action of a seaway will serve to make them audible. The rising and the falling of the waves cause the buoys to ring their bells or to blow their warning blasts, according to their kind. A series of suspended clappers or a number of rolling metal balls, traveling in grooves, are the mediums by which the bell of a buoy is struck; but the method of operating a whistling buoy is not so simple, and here it is that compressed air is made to perform useful work.



The whistling buoy is a successful example of the utilization of wave power, because it is the motion of the buoy, induced by the supporting waves, that compresses the air which blows the whistle more or less vigorously—depending upon the size of the billows. This will be readily understandable by reference to the accompanying vertical section of a type of whistling buoy extensively employed by the governmental service in question. Buoys of this sort are usually anchored in decidedly exposed positions where even moderate winds will kick up a fairly pronounced sea. Further, they are placed in deep water where they will have plenty of latitude in a vertical direction so that they can "pump" up and down without striking the bottom. This is necessary because the balancing or stabilizing feature of these buoys is a long and large tube which may be likened to the stem of a mushroom. The tube also constitutes an important part of the air compressing phase of the whistling buoy.

The tube is about 20 feet in length with an internal diameter of a trifle more than 20 inches, and this cylinder projects below the bottom of the buoy for approximately 16¾ feet. It is open at the lower end and sealed at the top where it is secured to a horizontal diaphragm which serves to divide the interior of the buoy into two watertight compartments—one above and one below this steel partition. The chamber formed by the tube is in communication with two vertical pipes extending upward to the top or deck of the body of the buoy. To one of these pipes is fitted a whistle much like the kind used on steamboats, locomotives, and factory buildings while the other, which is the air inlet pipe, is provided with a check valve.

The manner in which the buoy operates is as follows: Because of its mass, the buoy is shot somewhat out of the water on rising upon the crest of a wave and correspondingly immersed below its normal water line when it drops into the trough of a sea. This pumping action causes air to be drawn in through the inlet pipe as the buoy moves upward; and the moment it ceases to inhale, the check valve closes and prevents the escape of the air by that route. The confined air is then caught between the column of water within the tube and the diaphragm; and the weight of the descending buoy compresses this air and a moment later forces it upward and outward through the pipe leading to the surmounting whistle. The degree of compression and, therefore, the pitch and the loudness of the whistle blasts vary with the height of the waves and the speed with which the buoy rises and falls upon them.

The foregoing general description should make it clear why the whistle gives forth little more than a moan in an easy undertow and fairly shrieks when a storm is at its worst. As might be expected, these steel structures are sturdily built so that they will remain watertight and undamaged despite exposure to the pounding blows of mountainous waves. Every now and then one of these bulky navigational aids breaks loose from its mooring chain or anchor and is carried off before the sweep of the sea and the driving wind. Occasionally, these wanderings are somewhat protracted, and it may be months before the truant is overtaken and recovered. Some years ago a buoy on our Atlantic seaboard went adrift.

This buoy, which was planted near Nantucket Shoals light vessel, broke loose during a heavy January blow. It was not captured until the middle of August of the year following; and in that interval it traveled more than 3,300 knots, dragging with it a considerable portion of its mooring chain. Long before it was reclaimed the buoy was seen wallowing in the Atlantic 165 miles west and south of Bermuda; and yet for months thereafter it managed to keep out of sight of shipping traveling north and south over our busy coastal waters. When picked up, the buoy was still whistling

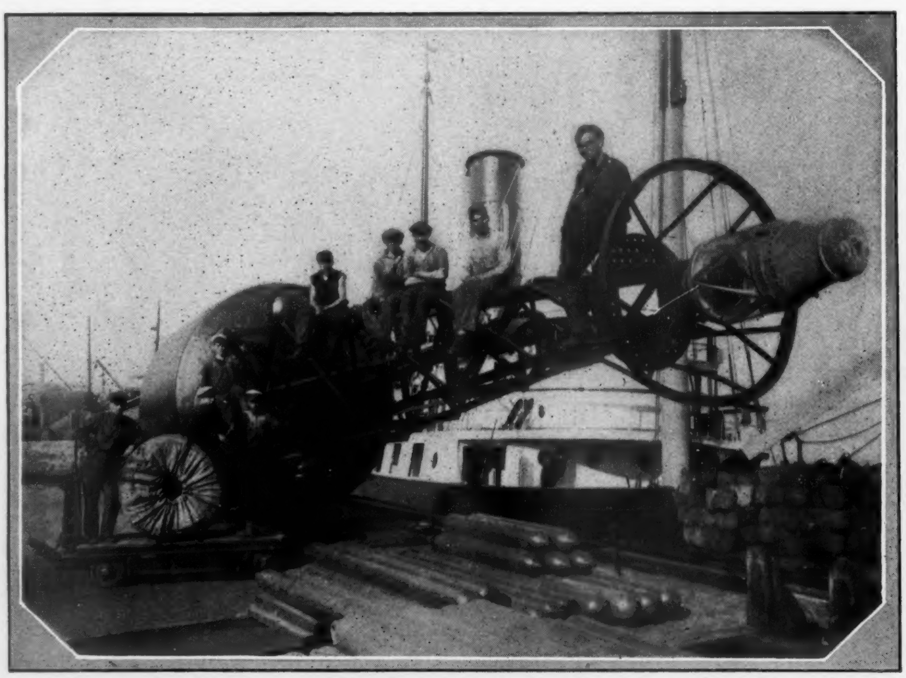
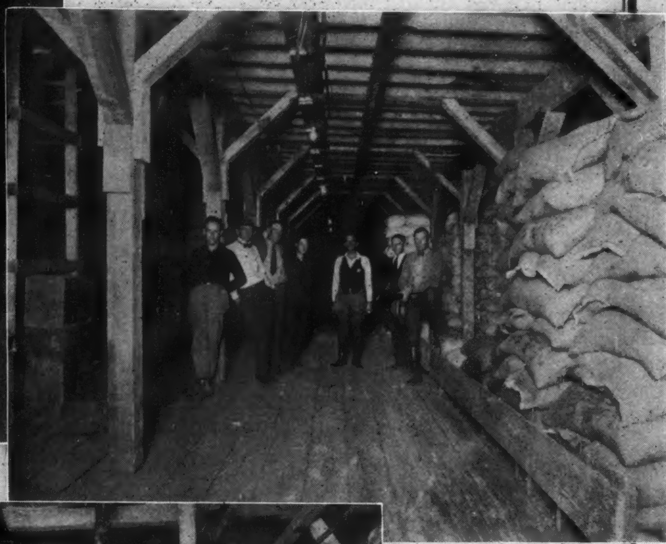


Photo., Keystone View Company.

This gives some idea of the size of a big whistling buoy. The long tube projecting from the bottom of the buoy body is not visible; but in a general way the get-up of this navigational aid is like the sectional drawing shown above.

Some Inside Aspects of the Hydro-Electric Developments on Big Creek in Southern California



These photographs, kindly furnished by the Southern California Edison Company, show us some of the things that go on behind the scenes, so to speak, of the Big Creek hydro-electric project. Here we see "drill doctors" cleaning and lubricating the drills that are helping to drive the tunnels, and we also get a hint of the massive timbers that must be put in place to bolster up the rock wherever it is rotten or inclined to cave in. Likewise, we have graphic evidence of how the men on the job are kept fit by proper and abundant food.

Compressed Air Magazine

—Founded 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:
Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries, $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

WILLIAM LAWRENCE SAUNDERS
President
G. W. MORRISON
Treasurer and General Manager
ROBERT G. SKERRETT
Editor
FRANK RICHARDS
Associate Editor
M. V. MCGOWAN
A. M. HOFFMANN
VERNON H. VAN DIVER
Assistant Editors
JOSEPH W. SHARP
Secretary

FOREIGN CORRESPONDENTS
Paris
BEN K. RALEIGH
10, Square Desonuettes, 19 Boulevard Victor
London
ROLAND H. BRIGGS
No. 165, Queen Victoria St., E. C. 4
Vienna
HERMANN BRINKMANN
No. 3, Tuchlauben, 1
Madrid
LUIS BALDASANO Y LOPEZ
No. 7, Jorge Juan
Canada
F. A. MCLEAN
Sherbrooke, Quebec

EDITORIALS

WATCH YOUR CHECKS

MONEY in circulation represents only one hundredth of the value of the 6,500,000,000 checks that are drawn in the course of a single twelvemonth in this country. It is authoritatively computed that 95 per cent. of the business in the United States is transacted through the medium of checks or other instruments of credit. By reason of carelessness in filling out or in subsequently handling these bits of negotiable paper many opportunities are offered the criminally disposed to make wrongful use of them in one way or another. A pecuniary loss of fully $100,000,000 yearly is laid to forgery, including the passing of worthless and bogus checks.

Because of this needless monetary sacrifice, the American Bankers' Association is back of a campaign to induce greater care on the part of the drawers of checks and, similarly, to persuade the rightful owners of canceled checks either to destroy these checks or to keep them under lock and key. As the Association puts it: "Safeguard your checks as you would your money. Keep your check books securely locked up and be careful how and where you sign or exhibit your signature. Beware of the magic of the word 'certified.' Ordinary certification stamps can be duplicated as easily as any other rubber stamp. Watch checks which apparently bear the maker's O. K. or other form of approval. They are more easily forged than the full signature. Guard your canceled vouchers as you would a valid check, leaving none where it may be easily taken." All of this is good and sound advice and may be heeded to advantage.

MORE POWER PRACTICABLE FROM NIAGARA FALLS

BECAUSE of the impressive majesty of Niagara Falls as a natural spectacle, it has been urged on many occasions that nothing further should be permitted that might lessen the volume of water flowing over the two great cataracts. Conversely, scientists and engineers, with an eye to the economic value of the power represented by those descending waters, have just as stoutly advocated a greater utilization of that source of tremendous energy.

A monograph lately issued by the Smithsonian Institution takes the stand that a good deal more power can be garnered from Niagara Falls without impairing their scenic beauty. To begin with, we are told that 94 per cent. of the water flowing down the river passes over the Canadian part of the falls and that the erosive action of this water is wearing away the underlying rock and causing the lip of this ledge to recede at the rate of five feet annually. In other words, this volume of unused water is gradually destroying the very spectacle which the lovers of natural beauty would have preserved.

On the face of it, it is self-evident that further harmful erosion can be checked easiest by diverting a greater measure of the water before it reaches the falls. In doing this, the sidetracked water should, of course, be turned to effective service in generating large blocks of electric energy. According to the author of the monograph, DR. SAMUEL S. WYER, it would be entirely feasible to obtain two and a half times as much power as is now produced by the adjacent power houses and still leave enough water to provide "an adequate scenic effect" at the falls.

DOCTOR WYER informs us that the total amount of water now flowing over the American and the Canadian falls is 205,000 cubic feet every second. He is positive that 50,000 cubic feet would be ample to furnish thrills for honeymooners and other visitors. Under the existing treaty arrangement between the United States and Canada, it is now permissible for the two countries concerned to divert for power purposes a total of not more than 56,000 cubic feet per second—a volume of water capable of producing with the facilities installed approximately 1,000,000 H.P. If the amount of diverted water were increased by 87,800 cubic feet a second it would then be practicable to generate 1,600,000 additional horse-power—assuming the waterwheels to be no more efficient than those at present in service. If we put the value of this supplemental block of energy at only $25 per horse-power per annum, the gain by the increased utilization of the waters of Niagara Falls would be equivalent to $40,000,000 in the course of a twelvemonth.

As has been asked on numerous occasions in the past, and as we ask again now: "Can we afford to make this sacrifice that would mean so much merely to preserve the spectacle in its existing magnitude? Knowing what it would mean to millions of us to have a greater measure of horse-power at our disposal, we should hesitate to insist upon allowing a needless wastage of water-power especially when the natural forces of the water are gradually working a harmful transformation that will inevitably impair the impressiveness of Niagara Falls.

A NEW FORM OF COMPASS

IT WAS not until the gyro-compass came into being a few years ago that mariners were able to divorce themselves from dependence upon the magnetic compass originally conceived by the Chinese centuries earlier. Now, thanks to the peculiar demands made upon inventive genius by aerial navigation, something has recently been devised which may be of great aid not only to the seafarer but to the sky pilot. The new instrument is known as the earth induction compass, and is the joint product of two scientists of the United States Bureau of Standards.

Because of the great speeds and the rapid changes in direction which characterize the flight and the maneuvering of airplanes, the ordinary mariner's compass is too sluggish in its action and too slow in coming to rest when suddenly oscillated by the abrupt alterations of course or by the heeling or pitching of a flying machine. Therefore, experiments were started to provide an apparatus which would indicate direction by responding to the influence of the invisible network of magnetic lines of force which covers the earth. Similar attempts had been made to evolve a compass of this nature during the World War, but these efforts were unsuccessful.

After much research, DRS. PAUL R. HEYL and L. J. BRIGGS solved the problem; and in recognition of their fine achievement they were rewarded the Magellan gold medal for the best invention pertaining to navigation. All the airplanes which took part in the memorable flight around the world in 1924 were equipped with earth induction compasses. The principle upon which this type of compass works is thus described in a *Research Narrative* recently issued by the United Engineering Society:

"If a coil of wire is rapidly rotated in the earth's magnetic field, an electric current is generated in the coil, the intensity of which depends upon the orientation of the axis of the coil with respect to the earth's network of magnetic lines of force. If the current is taken from such a coil by means of brushes and commutators, as with a direct-current electrical machine, the current depends also upon the position of these brushes with respect to the lines of force." Therefore, to make these changes of use to the navigator, the Washington scientists had to design a mechanism which would

translate these fluctuations and make them visible by means of a suitable compass card and a shifting index hand.

Thus, systematic research by trained men has given the world a surer and a safer guide for the navigator afloat or for his counterpart aloft in the air.

OUR FAVORABLE TRADE BALANCE

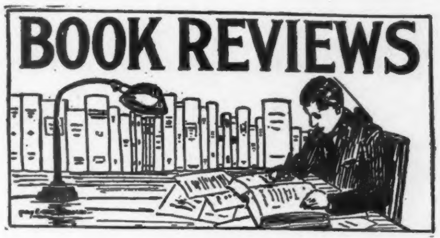
ACCORDING to the principles of international trade it is highly desirable that the outflow of commodities should exceed the value of those coming in—always assuming that foreign buyers pay their bills. Figures recently made public by the United States Department of Commerce discloses that there is a trade balance in our favor of nearly $1,000,000,000 for 1924. That is to say, our exports had a value of $4,588,266,000 while our imports for the same period represented $3,610,980,000—a difference of $977,286,000.

This status of our financial relations with traders abroad is a significant and a very encouraging one, recalling as we can that for many years our trade balance regularly showed that our imports were of far greater value than our exports. In other words, we gave more encouragement to foreign producers than foreign buyers gave to our industries. No doubt, this condition of affairs had much to do with our comparative indifference to the upbuilding of an American merchant marine commensurate with the magnitude of our country.

Except during 1919 and 1920, when afterwar demands played a big part in stimulating an abnormal volume of trade, we have never sold so much in the markets of the world as we did in the year just gone. In a large measure, the continuance of this favorable tide of commerce depends upon ourselves. We can hold this advantage if we display wisdom and proper energy in our dealings with the merchants and the financiers of other countries.

The big tunnel to be built under the Mersey, at Liverpool, is of special interest to us at the present time in view of the progress being made in driving the twin vehicular tunnels beneath the Hudson River, at New York City. Although the English undertaking calls for a single tunnel, the capacity of that tube will be greater than that of the American tunnel as it is to carry four rows of vehicles in an upper division and two lines of tramways in a lower one. Continuous traffic in both directions will complicate the ventilating problem, the solution of which will be the most interesting phase of the entire project.

While working on the new Truckee River highway near Reno, Nev., a steam shovel encountered a solid body of ice, measuring 60x20x10 feet, covered with 12 feet of earth. The workmen were finally compelled to use high explosives to break a way through the obstruction. The ice, supposed to be at least 40 years old, is assumed to have been a field of snow that was buried and compressed by an enormous landslide on the mountain above.



HISTORY OF PORTLAND CEMENT INDUSTRY IN THE UNITED STATES, by Robert W. Lesley, first president of the Portland Cement Association. A book of 330 pages extensively illustrated. Published by International Trade Press, Inc., New York City. Price, $3.00.

IT would be hard for the average citizen to grasp offhand what the domestic development of the Portland cement industry has done to advance structural engineering and architecture in their manifold fields of service. But well-nigh anyone will understand the significance of a group of plants capable of turning out in the course of a year nearly 137,500,000 barrels of a given commodity, which was the output during 1923. In 1924, production reached a little less than 150,000,000 barrels; and it should be self-evident that an enormous quantity of essential raw materials had to be mined or dug out of the earth to make these performances possible.

The most interesting angle of this subject has to do with the rather brief period of years within which the industry has grown to its magnificent proportions of today, and how difficulties have been overcome step by step and apparatus devised wherewith to manufacture and to make ready for shipping this extensively utilized building material. The book in question covers these phases of the matter as well as many others, and should prove a welcome source of authentic information.

AN INTRODUCTION TO THE ECONOMICS OF AIR TRANPORTATION, by Thomas Hart Kennedy. This is a work of 154 pages with numerous interesting illustrations. Published by The Macmillan Company, New York City. Price, $2.00.

THE author has set himself the task of providing a practical handbook dealing essentially with the economics of air transportation; and in order to obtain first-hand information he has studied his subject both at home and abroad. In the summer of 1923 he was carried by regular air lines in Europe an aggregate distance of 2,170 miles. As might be expected, Mr. Kennedy has sketched the historical background of the development of both the lighter-than-air craft as well as that of the heavier-than-air flying machine, and has followed this exposition with an analysis of the technical features of the oustanding examples of these two general classes.

Mr. Kennedy is of the belief that aerial navigation on a commercial scale will expand the faster the more the general public becomes familiar with this mode of carrying passengers and paying freight; and he refers to the hampering conditions which for a long while slowed up the development of our steam railways—conditions that were greatly influenced by lack of vision and comprehension on the part of the people at large.

In his foreword, the author says: "Speed in an element in all good transportation service. Air transportation is admittedly the most rapid form of transportation. Is the addition of this desirable quality, speed, justified from the standpoint of transportation economics? Is the air transportation business a profitable business? If not, what can be done to make the operation of aircraft profitable?" Consideration of the fairly full information which Mr. Kennedy has brought together in his book will help the reader to formulate intelligent answers to these queries.

RAILWAY ELECTRIFICATION, by H. F. Trewman, M.A., A.M.I.E.E., assistant professor of electrical engineering, Artillery College, Woolwich, England. An illustrated volume of 244 pages. Published by Isaac Pitman & Sons, New York City. Price, $7.50.

PROFESSOR Trewman has undertaken to prepare a complete survey of the economics of different systems of railway electrification considered from the engineering and the financial points of view. He begins his preface as follows: "Electrification of railways has assumed enormous importance since the war and the object of this work is to present to the serious students of railway engineering a number of the various problems encountered, with especial reference to the financial aspect." He freely admits that much of the data upon which he had to draw was applicable to prewar conditions and therefore not infrequently misleading. However, he tells us, "I have, by examining large numbers of cases, arrived at figures which will be representative and comparative although their absolute values may change with changing conditions." The book contains much material which should be helpful to persons interested in this field of engineering.

Notes on deep-level winding is the title of a paper by J. H. Vaughan, presented at the Empire Mining and Metallurgical Congress, London. This excellent paper has recently been reprinted and issued by the Transvaal Chamber of Mines, Johannesburg, South Africa. As usual, Mr. Vaughan has taken great pains to compile a wealth of valuable information and to present his subject in a lucid and a well-developed manner. Those of the engineering fraternity that have to do with mining, especially operations that are carried deep into the bowels of the earth, will immediately recognize the importance of the topic in question.

The *Manufacturers Record* is doing excellent and most effective work in the promotion of true Americanism in the South—the section of our Union to which it is devoting itself exclusively. That it is incidentally finding profit in the work is evidenced by the presentation to all its subscribers of a magnificent volume, entitled *The South's Development,* supplementary to its issue of December 2. To speak of the work adequately, and as we should wish, would take more space than is at our disposal.

There are 670 beautifully printed pages, and 400 of these are closely packed with carefully prepared matter copiously illustrated with attractive pictures which help to strengthen the various articles. The issue is entirely a busi-

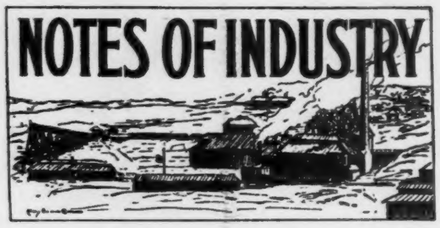
ness review; and all the industrial interests are represented, namely: agriculture, mining, manufactures, transportation, and world commerce. Voluminous statistics and data set forth the marvelous growth of the South to date, the glowing activities of the present, and the splendid promise for the years to come.

The annual report of the Director of the Bureau of Mines, United States Department of the Interior, is briefer than usual but especially significant by reason of the nature of some of the subjects dealt with. We are told, for instance, that non-fatal injuries at coal mines in the United States number approximately 200,000 yearly and represent a total lost production of coal valued at about $39,000,000. Further, the director informs us that "half the accidents and deaths that now occur in the coal mines of the country could probably be eliminated by more adequate safety supervision by operating companies and the exercise of greater care by mine employees."

Further, the report discusses the conservation of our petroleum and natural-gas resources; touches upon domestic oil-shale investigations; and stresses the advantages we enjoy in the possession of a priceless national asset in the form of an abundance of helium gas.

A short time ago, according to *American Machinist,* there was broken in a machine shop in San Francisco a small part of a much needed machine. The manager immediately wired the makers in Cambridge, Mass., for a replacement piece. With equal dispatch, the manufacturer started it westward by air mail. Despite winter weather and storms encountered while flying over intervening mountain ranges, the part was delivered promptly and the machine was ready again for business within 36 hours after the wire was sent.

India covers an area of approximately 1,800,000 square miles, or nearly half that of continental United States.



The United States is the world's largest consumer of fresh fruits.

It has been estimated that Canada's falling waters are capable of developing a minimum of 18,250,000 H.P. Of this total 3,227,000 H.P. has been made available.

In Canada there is a mile of railroad for every 90 square miles of territory and 220 people, as compared with a mile per 11½ square miles and 418 persons in the United States, according to B. V. York of the Transportation Division of the Department of Commerce. Canada has two trans-continental railway systems: a privately owned line, 15,000 miles long, and a government-owned line, less advantageously located, 22,000 miles in length. Both systems are being extended to meet the demands of shippers. The government is now discussing the question of building a railroad to Hudson Bay to shorten the rail haul for wheat *en route* to Europe.

More than 4,000,000 pounds of copper are used annually in the photo-engraving and electrotyping industries, according to the Copper & Brass Research Association.

Fully 65 per cent. of the rapidly growing trade of the Philippine Islands is with the United States, as against but 13 per cent. at the close of the Spanish regime.

The United States produces nearly every kind of commodity that Mexico buys abroad, and contributes more than 70 per cent. of her total imports.

The United States still dominates the world's production of iron and steel. An interesting development in connection with the steel industry in the United States, according to G. E. Phoebus of the Iron and Steel Division of the Department of Commerce, is that the center of steel production is gradually shifting westward. Fewer open-hearth and blast furnaces are being built east of the Ohio-Pennsylvania line than west of it.

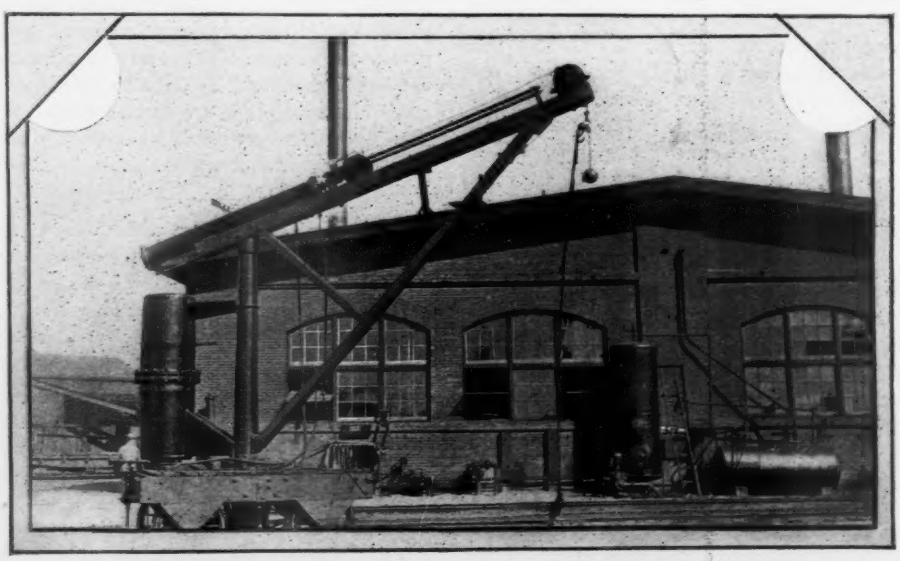
The cigarette-smoking habit is on the increase the world over, if statistics are any indication of the way the wind is blowing. In the United States a total of 63,000,000,000 was consumed in 1923 as against 15,000,000,000 in 1913—a fourfold gain in a decade.

The yearly output of coal of the British Empire Steel Corporation amounts to 6,000,000 tons, and 70 per cent. of this coal is obtained from mines under the sea. One of the largest of these, three square miles in area, is two miles off the shore of Sydney, Nova Scotia. Here a complete modern engineering plant is installed, equipped with ample power and every requirement for the sinking of shafts, the driving of galleries, the laying of tracks, and the running of coal trains. A plenty of air, light, water, and food is also provided so that the armies of miners may work under the same safe, healthful, and comfortable conditions as prevail in the best land mines.

Cryolite, a mineral now of some industrial importance, is mined only in Greenland, where it was discovered by the Danes in 1794. The Eskimos thought the substance a form of ice, inasmuch as it melts easily even in the heat of a candle flame and is generally translucent—being almost transparent in water. It is likewise found, but to a limited extent, near Pike's Peak, in Colorado. As for its usefulness, cryolite is a source of metallic aluminum—that is, it is utilized more as a flux in smelting that metal. It is also employed in the manufacture of certain sodium salts and some kinds of porcelain and glass noteworthy because of their toughness.

According to a recent announcement of the Secretary of the Interior, we are to have another national park in the eastern part of the United States. This great playground for the people is to be known as Shenandoah National Park; it will embrace approximately 700 square miles; and will extend into eight counties lying between Front Royal and Waynesboro, Va. The region, besides being mountainous and picturesque, is of much historic interest inasmuch as it was the scene of many of the battles of the Revolution and of the Civil War.

For the first time in history, Spain is in direct cable communication with the United States. The service was started on January 19, and is eventually to be extended so as to include Italy. The cable now runs from Malaga to the Azores and thence to the United States.



In the days when the Southern Pacific Railroad burned coal in the boilers of its locomotives this derrick was used to load coal into the tenders, but when oil was adopted as a fuel the hoist was no longer required for its original service. To make the derrick and others like it fit for other work they were equipped with air-operated lifts; and so modified they have proved very useful.

II

rld's
sting
l in-
o G.
n of
cen-
fting
fur-
Penn-

crease
cation
United
sumed
913—a

British
s to
coal is
One of
iles in
Sydney,
n engi-
ample
sinking
laying
trains
is also
rs may
ul, and
he best

ndustrial
l, where
04. The
n of ice,
heat of
slucent—
is like-
ar Pike's
ess, cryo-
—that is,
ting that
nufacture
kinds of
cause of

nt of the
to have
n part of
layground
henandoah
roximately
into eight
oyal and
ides being
much his-
the scene
lution and

Spain is
the United
on January
ed so as
from Ma
the Unite